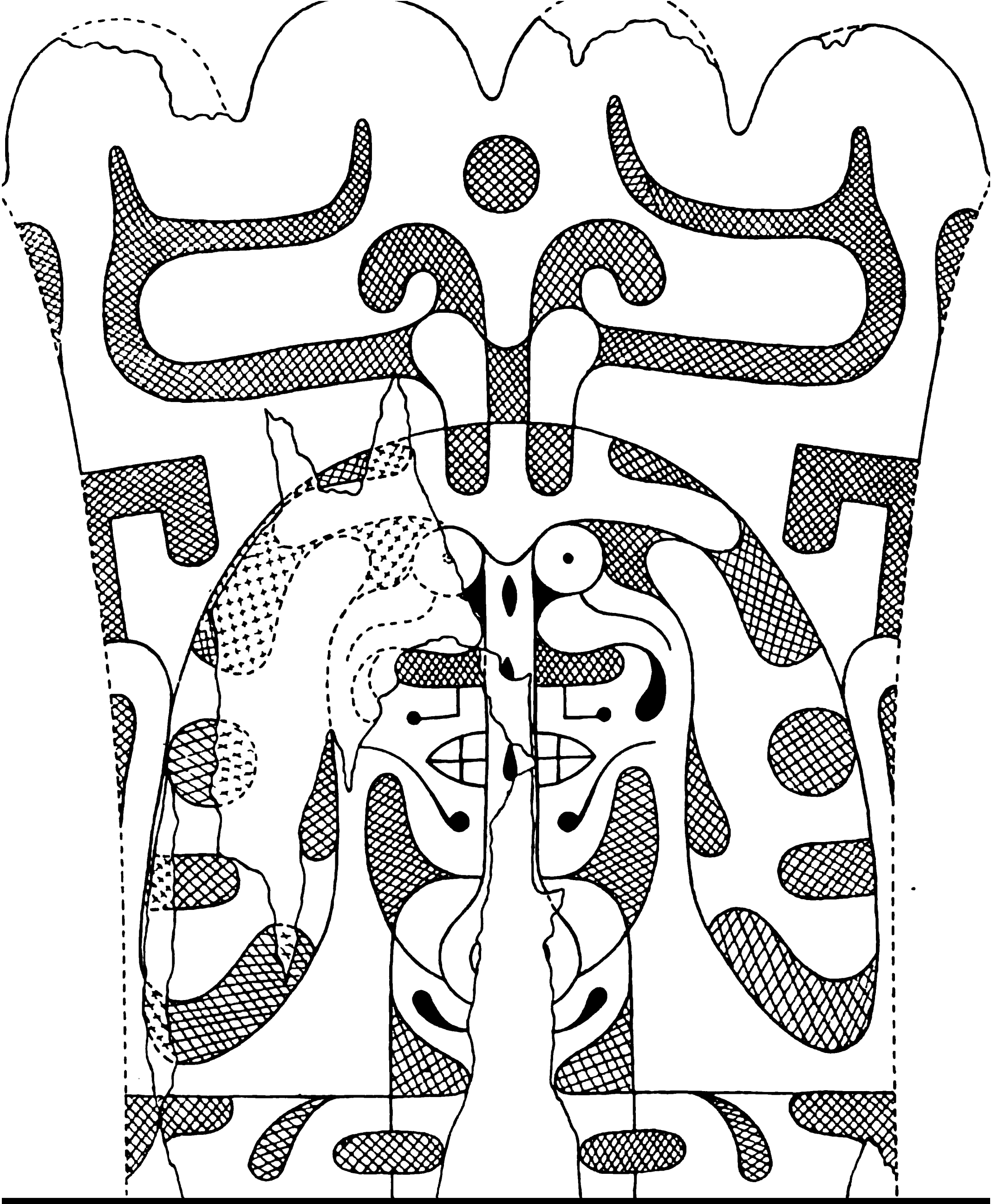

Proceedings of the American Association for the ...

American Association for the Advancement of Science

PROCEEDINGS

OF

THE AMERICAN ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE

FOR THE FORTY-FOURTH MEETING

HELD AT

SPRINGFIELD, MASS.

AUGUST-SEPTEMBER, 1895.

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From the Association at Large.—To hold over until successors are elected. A fellow elected from each section.—C. A. WALDO of Greencastle (A); HENRY S. CARHART of Ann Arbor (B); J. F. MCGREGORY of Hamilton (C); ARTHUR BEARDSLEY of Swarthmore (D); H. L. FAIRCHILD of Rochester (E); CHAS. SEDGWICK MINOT of Boston (F); B. L. ROBINSON of Cambridge (G); ALICE C. FLETCHER of Washington (H); H. E. ALVORD of Lewinsville (I).

SPECIAL COMMITTEES OF THE ASSOCIATION.[1]

1. *Auditors.*

EMORY MCCLINTOCK, Morristown. | B. A. GOULD, Cambridge.

2. *Committee on Indexing Chemical Literature.*

H. CARRINGTON BOLTON, New York,
F. W. CLARKE, Washington,
A. R. LEEDS, Hoboken,
H. W. WILEY, Washington,
J. W. LANGLEY, Pittsburgh,
A. B. PRESCOTT, Ann Arbor,
ALFRED TUCKERMAN, Newport.

3. *Committee on the Association Table in Biological Laboratory at Woods Holl.*

VICE PRESIDENTS OF SECTIONS F and G. | C. O. WHITMAN, Chicago.

4. *Committee on the Policy of the Association.*

THE PRESIDENT,
THE PERMANENT SECRETARY,
R. S. WOODWARD,
T. C. MENDENHALL,
JAS. LEWIS HOWE,
MANSFIELD MERRIMAN,
H. L. FAIRCHILD,
C. S. MINOT,
C. R. BARNES,
FRANZ BOAS,
WM. H. BREWER.

5. *Committee on Standards of Measurements.*

T. C. MENDENHALL, *Chairman.*
W. A. ROGERS,
E. L. NICHOLS,
R. S. WOODWARD,
H. A. ROLAND,
H. S. CARHART.
With power to add to its number.

6. *Committee on Standard Colors and Standard Nomenclature of Colors.*

O. N. ROOD, *Chairman.* | W. LECONTE STEVENS,
WILLIAM HALLOCK.

7. *Committee on the Association Library.*

ALFRED SPRINGER, *Chairman.*
A. W. BUTLER,
W. L. DUDLEY,
T. H. NORTON,
THOS. FRENCH, JR.

[1] All Committees are expected to present their reports to the COUNCIL not later than the third day of the meeting. Committees sending their reports to the Permanent Secretary one month before a meeting can have them printed for use at the meeting.

MEETINGS AND OFFICERS OF THE AMERICAN ASSOCIATION OF GEOLOGISTS AND NATURALISTS.

MEETING.	DATE.	PLACE.	CHAIRMAN.	SECRETARY.	ASSIS'T SEC'Y.	TREASURER.
1st	April 2, 1840,	Philadelphia,	Edward Hitchcock,*	L. C. Beck,*		
2d	April 5, 1841,	Philadelphia,	Benjamin Silliman,*	L. C. Beck.*	B. Silliman, Jr.,* C. B. Trego,*	
3d	April 25, 1842,	Boston,	S. G. Morton,*	C. T. Jackson,*	J. D. Whitney, M. B. Williams,*	
4th	April 26, 1843,	Albany,	Henry D. Rogers,*	B. Silliman, jr.,*		John Locke.*
5th	May 8, 1844,	Washington,	John Locke,*	B. Silliman, jr.,* O. P. Hubbard,		Douglas Houghton.*
6th	April 30, 1845,	New Haven,	Wm. B. Rogers,*	B. Silliman, jr.,* J. Lawrence Smith,*		Douglas Houghton.*
7th	Sept. 2, 1846,	New York,	C. T. Jackson,*	B. Silliman, jr.,*		E. C. Herrick.*
8th	Sept. 20, 1847,	Boston,	Wm. B. Rogers,†*	Jeffries Wyman,*		B. Silliman, Jr.*

* Deceased.

† Professor ROGERS, as chairman of this last meeting, called the first meeting of the new Association to order and presided until it was fully organized by the adoption of a constitution. As he was thus the first presiding officer of the new Association, it was directed at the Hartford meeting that his name be placed at the head of the Past Presidents of the American Association for the Advancement of Science.

MEETINGS.	PLACE.	DATE.	MEMBERS IN ATTENDANCE.	NUMBER OF MEMBERS.
1.	Philadelphia	Sept. 20, 1848	?	461
2.	Cambridge	Aug. 14, 1849	?	540
3.	Charleston	Mar. 12, 1850	?	622
4.	New Haven	Aug. 19, 1850	?	704
5.	Cincinnati	May 5, 1851	87	800
6.	Albany	Aug. 19, 1851	194	769
7.	Cleveland	July 28, 1853	?	940
8.	Washington	April 26, 1854	168	1004
9.	Providence	Aug. 15, 1855	166	605
10.	2nd Albany	Aug. 20, 1856	381	722
11.	Montreal	Aug. 12, 1857	351	946
12.	Baltimore	April 28, 1858	190	962
13.	Springfield	Aug. 3, 1859	190	862
14.	Newport	Aug. 1, 1860	135	644
15.	Buffalo	Aug. 15, 1866	79	687
16.	Burlington	Aug. 21, 1867	73	415
17.	Chicago	Aug. 5, 1868	259	686
18.	Salem	Aug. 18, 1869	244	511
19.	Troy	Aug. 17, 1870	188	536
20.	Indianapolis	Aug. 16, 1871	196	668
21.	Dubuque	Aug. 15' 1872	164	610
22.	Portland	Aug. 20, 1873	195	670
23.	Hartford	Aug. 12, 1874	224	722
24.	Detroit	Aug. 11, 1875	165	807
25.	2nd Buffalo	Aug. 23, 1876	215	867
26.	Nashville	Aug. 29, 1877	173	953
27.	St. Louis	Aug. 21, 1878	134	962
28.	Saratoga	Aug. 27, 1879	256	1030
29.	Boston	Aug. 25, 1880	997	1555
30.	2nd Cincinnati	Aug. 17, 1881	500	1699
31.	2nd Montreal	Aug. 23, 1882	937	1922
32.	Minneapolis	Aug. 15, 1883	328	2033
33.	2nd Philadelphia	Sept. 3, 1884	1261*	1981
34.	Ann Arbor	Aug. 26, 1885	364	1956
35.	3d Buffalo	Aug. 18, 1886	445	1886
36.	New York	Aug. 10, 1887	729	1956
37.	2nd Cleveland	Aug. 14, 1888	342	1964
38.	Toronto	Aug. 26, 1889	424	1952
39.	2d Indianapolis	Aug. 19. 1890	364	1944
40.	2d Washington	Aug. 19, 1891	653†	2054
41.	Rochester	Aug. 17, 1892	456	2037
42.	Madison	Aug. 17, 1893	290	1939
43.	Brooklyn	Aug. 15, 1894	488	1802
44.	2d Springfield	Aug. 28, 1895	368	1913
45.	4th Buffalo	Aug. 24, 1896	—	—

*Including members of the British Association and other foreign guests.
†Including twenty-four Foreign Honorary members for the meeting.

OFFICERS OF THE MEETINGS OF THE ASSOCIATION.

[The number before the name is that of the meeting; the year of the meeting follows the name; the asterisk after a name indicates that the member is deceased.]

PRESIDENTS.

1. { WM. B. ROGERS,* 1848. W. C. REDFIELD,* 1848.
2. JOSEPH HENRY,* 1849.

3, 4, 5. A. D. BACHE,* March meeting, 1850, in absence of Joseph Henry.* August meeting, 1850. May meeting, 1851.

6. LOUIS AGASSIZ,* August meeting, 1851.

(No meeting in 1852).

7. BENJAMIN PIERCE,* 1853.
8. JAMES D. DANA,* 1854.
9. JOHN TORREY,* 1855.
10. JAMES HALL, 1856.

11, 12. ALEXIS CASWELL,* 1857, in place of J. W. BAILEY,* deceased. 1858, in absence of JEFFRIES WYMAN.*

13. STEPHEN ALEXANDER,* 1859.
14. ISAAC LEA,* 1860.

(No meetings for 1861–65).

15. F. A. P. BARNARD,* 1866.
16. J. S. NEWBERRY,* 1867.
17. B. A. GOULD, 1868.
18. J. W. FOSTER,* 1869.
19. T. STERRY HUNT,* 1870, in the absence of WM. CHAUVENET.*
20. ASA GRAY,* 1871.
21. J. LAWRENCE SMITH,* 1872.
22. JOSEPH LOVERING,* 1873.
23. J. L. LECONTE,* 1874.
24. J. E. HILGARD,* 1875.
25. WILLIAM B. ROGERS,* 1876.
26. SIMON NEWCOMB, 1877.
27. O. C. MARSH, 1878.
28. G. F. BARKER, 1879.
29. LEWIS H. MORGAN,* 1880.
30. G. J. BRUSH, 1881.
31. J. W. DAWSON, 1882.
32. C. A. YOUNG, 1883.
33. J. P. LESLEY, 1884.
34. H. A. NEWTON,* 1885.
35. EDWARD S. MORSE, 1886.
36. S. P. LANGLEY, 1887.
37. J. W. POWELL, 1888.
38. T. C. MENDENHALL, 1889.
39. G. LINCOLN GOODALE, 1890.
40. ALBERT B. PRESCOTT, 1891.
41. JOSEPH LECONTE, 1892.
42. WILLIAM HARKNESS, 1893.
43. DANIEL G. BRINTON, 1894.
44. E. W. MORLEY, 1895.
45. EDWARD D. COPE, 1896.

VICE PRESIDENTS.

There were no Vice Presidents until the 11th meeting when there was a single Vice President for each meeting. At the 24th meeting the Association met in Sections A and B, each presided over by a Vice President. At the 31st meeting nine sections were organized, each with a Vice President as its presiding officer. In 1886, Section G (Microscopy) was given up. In 1892, Section F was divided into F, Zoology; G, Botany.

1857–1874.

11. ALEXIS CASWELL,* 1857, acted as President.
12. JOHN E. HOLBROOK,* 1858, not present.
13. EDWARD HITCHCOCK,* 1859.
14. B. A. GOULD, 1860.
15. A. A. GOULD,* 1866, in absence of R. W. GIBBES.
16. WOLCOTT GIBBS, 1867.
17. CHARLES WHITTLESEY,* 1868.
18. OGDEN N. ROOD, 1869.
19. T. STERRY HUNT,* 1870, acted as President.
20. G. F. BARKER, 1871.
21. ALEXANDER WINCHELL,* 1872.
22. A. H. WORTHEN,* 1873, not present.
23. C. S. LYMAN,* 1874.

1875–1881.

Section A.—Mathematics, Physics and Chemistry.

24. H. A. NEWTON, 1875.
25. C. A. YOUNG, 1876.
26. R. H. THURSTON, 1877, in the absence of E. C. PICKERING.
27. R. H. THURSTON, 1878.
28. S. P. LANGLEY, 1879.
29. ASAPH HALL, 1880.
30. WILLIAM HARKNESS, 1881, in the absence of A. M. MAYER.

Section B.—Natural History.

24. J. W. DAWSON, 1875.
25. EDWARD S. MORSE, 1876.
26. O. C. MARSH, 1877.
27. AUG. R. GROTE, 1878.
28. J. W. POWELL, 1879.
29. ALEXANDER AGASSIZ, 1880.
30. EDWARD T. COX, 1881, in the absence of GEORGE ENGELMANN.*

CHAIRMEN OF SUBSECTIONS, 1875–1881.

Subsection of Chemistry.

24. S. W. JOHNSON, 1875.
25. G. F. BARKER, 1876.
26. N. T. LUPTON, 1877.
27. F. W. CLARKE, 1878.
28. F. W. CLARKE, 1879, in the absence of IRA REMSEN.
29. J. M. ORDWAY, 1880.
30. G. C. CALDWELL, 1881, in the absence of W. R. NICHOLS.*

Subsection of Microscopy.

25. R. H. WARD, 1876.
26. R. H. WARD, 1877.
27. R. H. WARD, 1878, in the absence of G. S. BLACKIE.*
28. E. W. MORLEY, 1879.
29. S. A. LATTIMORE, 1880.
30. A. B. HERVEY, 1881.

Subsection of Anthropology.

24. LEWIS H. MORGAN,* 1875.
25. LEWIS H. MORGAN,* 1876.
26. DANIEL WILSON,* 1877, not present.
27. United with Section B.
28. DANIEL WILSON,* 1879.
29. J. W. POWELL, 1880.
30. GARRICK MALLERY,* 1881.

Subsection of Entomology.

30. J. G. MORRIS, 1881.

VICE PRESIDENTS OF SECTIONS, 1882–

Section A.—Mathematics and Astronomy.

31. W. A. ROGERS, 1882, in the absence of WILLIAM HARKNESS.
32. W. A. ROGERS, 1883.
33. H. T. EDDY, 1884.
34. WILLIAM HARKNESS, 1885, in the absence of J. M. VAN VLECK.
35. J. W. GIBBS, 1886.
36. J. R. EASTMAN, 1887, in place of W. FERREL,* resigned.
37. ORMOND STONE, 1888.
38. R. S. WOODWARD, 1889.
39. S. C. CHANDLER, 1890.
40. E. W. HYDE, 1891.
41. J. R. EASTMAN, 1892.
42. C. L. DOOLITTLE, 1893.
43. { G. C. COMSTOCK, 1894. EDGAR FRISBY, 1894. }
44. EDGAR FRISBY, 1895, in place of E. H. HOLDEN, resigned.
45. WM. E. STORY, 1896.

Section B.—Physics.

31. T. C. MENDENHALL, 1882.
32. H. A. ROWLAND, 1883
33. J. TROWBRIDGE, 1884.
34. S. P. LANGLEY, 1885, in place of C. F. BRACKETT, resigned.
35. C. F. BRACKETT, 1886.
36. W. A. ANTHONY, 1887.
37. A. A. MICHELSON, 1888.
38. H. S. CARHART, 1889.
39. CLEVELAND ABBE, 1890.
40. F. E. NIPHER, 1891.
41. B. F. THOMAS, 1892.
42. E. L. NICHOLS, 1893.
43. WM. A. ROGERS, 1894.
44. W. LECONTE STEVENS, 1895.
45. CARL LEO MEES, 1896.

Section C.—Chemistry.

31. H. C. BOLTON, 1882.
32. E. W. MORLEY, 1883.
33. J. W. LANGLEY, 1884.
34. N. T. LUPTON, 1885, in absence of W. R. NICHOLS.*
35. H. W. WILEY, 1886.
36. A. B. PRESCOTT, 1887.
37. C. E. MUNROE, 1888.
38. W. L. DUDLEY, 1889.
39. R. B. WARDER, 1890.
40. R. C. KEDZIE, 1891.
41. ALFRED SPRINGER, 1892.
42. EDWARD HART, 1893.
43. T. H. NORTON, 1894.
44. WM. MCMURTRIE, 1895.
45. W. A. NOYES, 1896.

Section D.—Mechanical Science and Engineering.

31. W. P. TROWBRIDGE,* 1882.
32. DE VOLSON WOOD, 1883, absent, but place was not filled.
33. R. H. THURSTON, 1884.
34. J. BURKITT WEBB, 1885.
35. O. CHANUTE, 1886.
36. E. B. COXE, 1887.
37. C. J. H. WOODBURY, 1888.
38. JAMES E. DENTON, 1889.
39. JAMES E. DENTON, 1890, in place of A. BEARDSLEY, absent.
40. THOMAS GRAY, 1891.
41. J. B. JOHNSON, 1892.
42. S. W. ROBINSON, 1893.
43. MANSFIELD MERRIMAN, 1894.
44. WILLIAM KENT, 1895.
45. FRANK O. MARVIN, 1896.

VICE PRESIDENTS OF SECTIONS, CONTINUED.

Section E.—Geology and Geography.

31. E. T. COX, 1882.
32. C. H. HITCHCOCK, 1883.
33. N. H. WINCHELL, 1884.
34. EDWARD ORTON, 1885.
35. T. C. CHAMBERLIN, 1886.
36. G. K. GILBERT, 1887.
37. GEORGE H. COOK,* 1888.
38. CHARLES A. WHITE, 1889.
39. JOHN C. BRANNER, 1890.
40. J. J. STEVENSON, 1891.
41. H. S. WILLIAMS, 1892.
42. CHARLES D. WALCOTT, 1893.
43. SAMUEL CALVIN, 1894.
44. JED. HOTCHKISS, 1895.
45. B. K. EMERSON, 1896.

Section F.—Biology.

31. W. H. DALL, 1882.
32. W. J. BEAL, 1883.
33. E. D. COPE, 1884.
34. T. J. BURRILL, 1885, in the absence of B. G. WILDER.
35. H. P. BOWDITCH, 1886.
36. W. G. FARLOW, 1887.
37. C. V. RILEY,* 1888.
38. GEORGE L. GOODALE, 1889.
39. C. S. MINOT, 1890.
40. J. M. COULTER, 1891.
41. S. H. GAGE, 1892.

Section F.— Zoölogy.

42. HENRY F. OSBORN, 1893.
43. J. A. LINTNER, 1894, in place of S. H. SCUDDER, resigned.
44. L O. HOWARD, 1895, in place of D. S. JORDAN, resigned.
45. THEO. N. GILL, 1896.

Section G.—Microscopy.

31. A. H. TUTTLE, 1882.
32. J. D. COX, 1883.
33. T. G. WORMLEY, 1884.
34. S. H. GAGE, 1885.

(Section united with F in 1886.)

Section G.—Botany.

42. CHARLES E. BESSEY, 1893.
43. { L. M. UNDERWOOD, 1894. / C. E. BESSEY, 1894. }
44. J. C. ARTHUR, 1895.
45. N. L. BRITTON, 1896.

Section H.—Anthropology.

31. ALEXANDER WINCHELL,* 1882.
32. OTIS T. MASON, 1883.
33. EDWARD S. MORSE, 1884.
34. J. OWEN DORSEY, 1885, in absence of W. H. DALL.
35. HORATIO HALE, 1886.
36. D. G. BRINTON, 1887.
37. CHARLES C. ABBOTT, 1888.
38. GARRICK MALLERY,* 1889.
39. FRANK BAKER, 1890.
40. JOSEPH JASTROW, 1891.
41. W. H. HOLMES, 1892.
42. J. OWEN DORSEY,* 1893.
43. FRANZ BOAS, 1894.
44. F. H. CUSHING, 1895.
45. ALICE C. FLETCHER, 1896.

Section I.—Economic Science and Statistics.

31. E. B. ELLIOTT,* 1882.
32. FRANKLIN B. HOUGH,* 1883.
33. JOHN EATON,* 1884.
34. EDWARD ATKINSON, 1885.
35. JOSEPH CUMMINGS,* 1886.
36. H. E. ALVORD, 1887.
37. CHARLES W. SMILEY, 1888.
38. CHARLES S. HILL, 1889.
39. J. RICHARDS DODGE, 1890.
40. EDMUND J. JAMES, 1891.
41. LESTER F. WARD, 1892, in place of S. DANA HORTON, resigned.
42. WILLIAM H. BREWER, 1893.
43. HENRY FARQUHAR, 1894.
44. B. E. FERNOW, 1895.
45. W. L. LAZENBY, 1896.

SECRETARIES.

General Secretaries, 1848–

1. WALTER R. JOHNSON,* 1848.
2. EBEN N. HORSFORD,* 1849, in the absence of JEFFRIES WYMAN.*
3. L. R. GIBBS, 1850, in absence of E. C. HERRICK.*
4. E. C. HERRICK,* 1850.
5. WILLIAM B. ROGERS,* 1851, in absence of E. C. HERRICK.*
6. WILLIAM B. ROGERS,* 1851.
7. S. ST. JOHN,* 1853, in absence of J. D. DANA.*
8. J. LAWRENCE SMITH,* 1854.
9. WOLCOTT GIBBS, 1855.
10. B. A. GOULD, 1856.
11. JOHN LECONTE,* 1857.
12. W. M. GILLESPIE,* 1858, in absence of WM. CHAUVENET.*
13. WILLIAM CHAUVENET,* 1859.
14. JOSEPH LECONTE, 1860.
15. ELIAS LOOMIS,* 1866, in the absence of W. P. TROWBRIDGE.*
16. C. S LYMAN,* 1867.
17. SIMON NEWCOMB, 1868, in place of A. P. ROCKWELL, called home.
18. O. C. MARSH, 1869.
19. F. W. PUTNAM, 1870, in absence of C. F. HARTT.*
20. F. W. PUTNAM, 1871.
21. EDWARD S. MORSE, 1872.
22. C. A. WHITE, 1873.
23. A. C. HAMLIN, 1874.
24. S. H. SCUDDER, 1875.
25. T. C. MENDENHALL, 1876.
26. AUG. R. GROTE, 1877.
27. H. C. BOLTON, 1878.
28 H. C. BOLTON, 1879, in the absence of GEORGE LITTLE.
29. J. K. REES, 1880.
30. C. V. RILEY,* 1881.
31. WILLIAM SAUNDERS, 1882.
32. J. R. EASTMAN, 1883.
33. ALFRED SPRINGER, 1884.
34. C. S. MINOT, 1885.
35. S. G. WILLIAMS, 1886.
36. WILLIAM H. PETTEE, 1887.
37. JULIUS POHLMAN, 1888.
38. C. LEO MEES, 1889.
39. H. C. BOLTON, 1890.
40. H. W. WILEY, 1891.
41. A. W. BUTLER, 1892.
42. T. H. NORTON, 1893.
43. H. L. FAIRCHILD, 1894.
44. JAS. LEWIS HOWE, 1895.
45. CHARLES R. BARNES, 1896.

Permanent Secretaries, 1851–

5–7. SPENCER F. BAIRD,* 1851–3.
8–17. JOSEPH LOVERING,* 1854–68.
18. F. W. PUTNAM, 1869, in the absence of J. LOVERING.*
19–21. JOSEPH LOVERING,* 1870–72.
22–23. F. W. PUTNAM, 1873–74.
24–28. F. W. PUTNAM, 1875–79.
29–33. F. W. PUTNAM, 1880–84.
34–38. F. W. PUTNAM, 1885–89.
39–43. F. W. PUTNAM, 1890–94.
44–48. F. W. PUTNAM, 1895–99.

Assistant General Secretaries, 1882-1887.

31. J. R. EASTMAN, 1882.
32. ALFRED SPRINGER, 1883.
33. C. S. MINOT, 1884, in the absence of E. S. HOLDEN.
34. S. G. WILLIAMS, 1885, in the absence of C. C. ABBOTT.
35. W. H. PETTEE, 1886.
36. J. C. ARTHUR, 1887.

Secretaries of the Council, 1888–

37. C. LEO MEES, 1888.
38. H. C. BOLTON, 1889.
39. H. W. WILEY, 1890.
40. A. W. BUTLER, 1891.
41. T. H. NORTON, 1892.
42. H. LEROY FAIRCHILD, 1893.
43. JAS. LEWIS HOWE, 1894.
44. CHARLES R. BARNES, 1895.
45. ASAPH HALL, JR., 1896.

Secretaries of Section A.—Mathematics, Physics and Chemistry, 1875–81.

24. S. P. LANGLEY, 1875. T. C. MENDENHALL, 1875.
25. A. W. WRIGHT, 1876.
26. H. C. BOLTON, 1877.
27. F. E. NIPHER, 1878.
28. J. K. REES, 1879.
29. H. B. MASON, 1880.
30. E. T. TAPPAN, 1881, in the absence of JOHN TROWBRIDGE.

Secretaries of Section B.— Natural History, 1875–81.

24. EDWARD S. MORSE, 1875.
25. ALBERT H. TUTTLE, 1876.
26. WILLIAM H. DALL, 1877.
27. GEORGE LITTLE, 1878.
28. WILLIAM H. DALL, 1879, in the absence of A. C. WETHERBY.
29. CHARLES V. RILEY,* 1880.
30. WILLIAM SAUNDERS, 1881.

SECRETARIES OF SUBSECTIONS, 1875–81.

Subsection of Chemistry.

24. F. W. CLARKE, 1875.
25. H. C. BOLTON, 1876.
26. P. SCHWEITZER, 1877.
27. A. P. S. STUART, 1878.
28. W. R. NICHOLS,* 1879.
29. C. E. MUNROE, 1880.
30. ALFRED SPRINGER, 1881, in the absence of R. B. WARDER.

Subsection of Entomology.

30. B. P. MANN, 1881.

Subsection of Anthropology.

24. F. W. PUTNAM, 1875.
25. OTIS T. MASON, 1876.
26, 27. United with Section B.
28, 29, 30. J. G. HENDERSON, 1879–81.

Subsection of Microscopy.

25. E. W. MORLEY, 1876.
26. T. O. SOMMERS, JR., 1877.
27. G. J. ENGELMANN, 1878.
28, 29. A. B. HERVEY, 1879-1880.
30. W. H. SEAMAN, 1881, in the absence of S. P. SHARPLES.

SECRETARIES OF THE SECTIONS, 1882–

Section A.—Mathematics and Astronomy.

31. H. T. EDDY, 1882.
32. G. W. HOUGH, 1883, in the absence of W. W. JOHNSON.
33. G. W. HOUGH, 1884.
34. E. W. HYDE, 1885.
35. S. C. CHANDLER, 1886.
36. H. M. PAUL, 1887.
37. C. C. DOOLITTLE, 1888.
38. G. C. COMSTOCK, 1889.
39. W. W. BEMAN, 1890.
40. F. H. BIGELOW, 1891.
41. WINSLOW UPTON, 1892.
42. C. A. WALDO, 1893, in the absence of A. W. PHILLIPS.
43. J. C. KERSHNER, 1894, in place of W. W. BEMAN, resigned.
44. ASAPH HALL, JR., 1895, in place of E. H. MOORE, resigned.
45. EDWIN B. FROST, 1896.

Section B.—Physics.

31. C. S. HASTINGS, 1882.
32. F. E. NIPHER, 1883, in the absence of C. K. WEAD.
33. N. D. C. HODGES, 1884.
34. B. F. THOMAS, 1885, in place of A. A. MICHELSON, resigned.
35. H. S. CARHART, 1886.
36. C. LEO MEES, 1887.
37. ALEX. MACFARLANE, 1888.
38. E. L. NICHOLS, 1889.
39. E. M. AVERY, 1890.
40. ALEX. MACFARLANE, 1891.
41. BROWN AYRES, 1892.
42. W. LECONTE STEVENS, 1893.
43. B. W. SNOW, 1894.
44. E. MERRITT, 1895.
45. FRANK P. WHITMAN, 1896.

SECRETARIES OF THE SECTIONS, CONTINUED.

Section C.—Chemistry.

31. ALFRED SPRINGER, 1882.
32. { J. W. LANGLEY, 1883. W. McMURTRIE, 1883.
33. H. CARMICHAEL, 1884, in the absence of R. B. WARDER.
34. F. P. DUNNINGTON, 1885.
35. W. McMURTRIE, 1886.
36. C. S. MABERY, 1887.
37. W. L. DUDLEY, 1888.
38. EDWARD HART, 1889.
39. W. A. NOYES, 1890.
40. T. H. NORTON, 1891.
41. JAS. LEWIS HOWE, 1892.
42. H. N. STOKES, 1893, in the absence of J. U. NEF.
43. MORRIS LOEB, 1894, in place of S. M. BABCOCK, resigned.
44. { W. P. MASON, 1895. W. O. ATWATER, 1895.
45. FRANK P. VENABLE, 1896.

Section D.—Mechanical Science and Engineering.

31. J. BURKITT WEBB, 1882, in the absence of C. R. DUDLEY.
32. J. BURKITT WEBB, 1883, *pro tempore.*
33. J. BURKITT WEBB, 1884.
34. C. J. H. WOODBURY, 1885
35. WILLIAM KENT, 1886.
36. G. M. BOND, 1887.
37. ARTHUR BEARDSLEY, 1888.
38. W. B. WARNER, 1889.
39. THOMAS GRAY, 1890.
40. WILLIAM KENT, 1891.
41. O. H. LANDRETH, 1892.
42. D. S. JACOBUS, 1893.
43. JOHN H. KINEALY, 1894.
44. H. S. JACOBY, 1895.
45. JOHN GALBRAITH, 1896.

Section E.—Geology and Geography.

31. H. S. WILLIAMS, 1882, in the absence of C. E. DUTTON.
32. A. A. JULIEN, 1883.
33. E. A. SMITH, 1884.
34. G. K. GILBERT, 1885, in the absence of H. C. LEWIS.*
35. E. W. CLAYPOLE, 1886.
36. W. M. DAVIS, 1887, in the absence of T. B. COMSTOCK.
37. JOHN C. BRANNER, 1888.
38. JOHN C. BRANNER, 1889.
39. SAMUEL CALVIN, 1890.
40. W J McGEE, 1891.
41. R. D. SALISBURY, 1892.
42. W. H. HOBBS, 1893, in place of R. T. HILL, resigned.
43. JED. HOTCHKISS, 1894, in place of W. M. DAVIS, resigned.
44. J. PERRIN SMITH, 1895.
45. A. C. GILL, 1896.

Section F.—Biology, 1882–92.

31. WILLIAM OSLER, 1882, in the absence of C. S. MINOT.
32. S. A. FORBES, 1883.
33. C. E. BESSEY, 1884.
34. J. A. LINTNER, 1885, in place of C. H. FERNALD, resigned.
35. J. C. ARTHUR, 1886.
36. J. H. COMSTOCK, 1887.
37. B. H. FERNOW, 1888.
38. A. W. BUTLER, 1889.
39. J. M. COULTER, 1890.
40. A. J. COOK, 1891.
41. B. D. HALSTED, 1892.

Section F.—Zoölogy.

42. L. O. HOWARD, 1893.
43. JOHN B. SMITH, 1894, in place of WM. LIBBY, JR., resigned.
44. C. W. HARGITT, 1895, in place of S. A. FORBES, resigned.
45. D. S. KELLICOTT, 1896.

SECRETARIES OF THE SECTIONS, CONTINUED.

Section G.—Microscopy, 1882–85.

31. ROBERT BROWN, JR., 1882.
32. CARL SEILER, 1883.
33. ROMYN HITCHCOCK, 1884.
34. W. H. WALMSLEY, 1885.

Section G.—Botany.

42. B. T. GALLOWAY, 1893, in the absence of F. V. COVILLE.
43. CHARLES R. BARNES, 1894.
44. { B. T. GALLOWAY, 1895. M. B. WAITE, 1895.
45. GEORGE F. ATKINSON, 1896.

Section H.—Anthropology.

31. OTIS T. MASON, 1882.
32. G. H. PERKINS, 1883.
33. G. H. PERKINS, 1884, in the absence of W. H. HOLMES.
34. ERMINNIE A. SMITH,* 1885.
35. A. W. BUTLER, 1886.
36. CHARLES C. ABBOTT, 1887, in absence of F. W. LANGDON.
37. FRANK BAKER, 1888.
38. W. M. BEAUCHAMP, 1889.
39. JOSEPH JASTROW, 1890.
40. W. H. HOLMES, 1891.
41. W. M. BEAUCHAMP, 1892, in place of S. CULIN, resigned.
42. WARREN K. MOOREHEAD, 1893.
43. A. F. CHAMBERLIN, 1894.
44. { STEWART CULIN, 1895. W. W. TOOKER, 1895, in place of ANITA N. MCGEE resigned.
45. JOHN G. BOURKE, 1896.

Section I.—Economic Science and Statistics.

31. { FRANKLIN B. HOUGH,* 1882. J. RICHARDS DODGE, 1882.
32. JOSEPH CUMMINGS,* 1883.
33. CHARLES W. SMILEY, 1884.
34. CHARLES W. SMILEY, 1885, in absence of J. W. CHICKERING.
35. H. E. ALVORD, 1886.
36. W. R. LAZENBY, 1887.
37. CHARLES S. HILL, 1888.
38. J. RICHARDS DODGE, 1889.
39. B. E. FERNOW, 1890.
40. B. E. FERNOW, 1891.
41. HENRY FARQUHAR, 1892, in place of L. F. WARD made Vice-president.
42. NELLIE S. KEDZIE, 1893.
43. MANLEY MILES, 1894.
44. W. R. LAZENBY, 1895, in place of E. A. ROSS, resigned.
45. R. T. COLBURN, 1896.

TREASURERS.

1. JEFFRIES WYMAN*, 1848.
2. A. L. ELWYN,* 1849.
3. ST. J. RAVENEL,* 1850, in the absence of A. L. ELWYN.*
4. A. L. ELWYN,* 1850.
5. SPENCER F. BAIRD,* 1851, in absence of A. L. ELWYN.*

6–7. A. L. ELWYN,* 1851–1853.

8. J. L. LECONTE,* 1854, in absence of A. L. ELWYN.*

9–19. A. L. ELWYN,* 1855–1870.

20–30. WILLIAM S. VAUX,* 1871–1881.

32–42. WILLIAM LILLY,* 1882–1893.

43–44. R. S. WOODWARD, 1894–96.

COMMONWEALTH OF MASSACHUSETTS.

IN THE YEAR ONE THOUSAND EIGHT HUNDRED AND SEVENTY-FOUR.

AN ACT

To Incorporate the "American Association for the Advancement of Science."

Be it enacted by the Senate and House of Representatives, in General Court assembled, and by the authority of the same, as follows:

Section 1. Joseph Henry of Washington, Benjamin Pierce of Cambridge, James D. Dana of New Haven, James Hall of Albany, Alexis Caswell of Providence, Stephen Alexander of Princeton, Isaac Lea of Philadelphia, F. A. P. Barnard of New York, John S. Newberry of Cleveland, B. A. Gould of Cambridge, T. Sterry Hunt of Boston, Asa Gray of Cambridge, J. Lawrence Smith of Louisville, Joseph Lovering of Cambridge and John LeConte of Philadelphia, their associates, the officers and members of the Association, known as the "American Association for the Advancement of Science," and their successors, are hereby made a corporation by the name of the "American Association for the Advancement of Science," for the purpose of receiving, purchasing, holding and conveying real and personal property, which it now is, or hereafter may be, possessed of, with all the powers and privileges, and subject to the restrictions, duties and liabilities set forth in the general laws which now or hereafter may be in force and applicable to such corporations.

Section 2. Said corporation may have and hold by purchase, grant, gift or otherwise, real estate not exceeding one hundred thousand dollars in value, and personal estate of the value of two hundred and fifty thousand dollars.

Section 3. Any two of the corporators above named are hereby authorized to call the first meeting of the said corporation in the month of August next ensuing, by notice thereof "by mail," to each member of the said Association.

Section 4. This act shall take effect upon its passage.

House of Representatives, March 10, 1874.
Passed to be enacted,
John F. Sanford, *Speaker*.

In Senate, March 17, 1874.
Passed to be enacted.
Geo. B. Loring, *President*.

March 19, 1874.
Approved,
W. B. Washburn.

Secretary's Department,
Boston, April 3, 1874.
A true copy, Attest:
David Pulsifer,
Deputy Secretary of the Commonwealth.

CONSTITUTION

OF THE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Incorporated by Act of the General Court of the Commonwealth of Massachusetts.

OBJECTS.

ARTICLE 1. The objects of the Association are, by periodical and migratory meetings, to promote intercourse between those who are cultivating science in different parts of America, to give a stronger and more general impulse and more systematic direction to scientific research, and to procure for the labors of scientific men increased facilities and a wider usefulness.

MEMBERS, FELLOWS, PATRONS AND HONORARY FELLOWS.

ART. 2. The Association shall consist of Members, Fellows, Patrons, Corresponding Members and Honorary Fellows.

ART. 3. Any person may become a Member of the Association upon recommendation in writing by two members or fellows, and election by the Council. Any incorporated scientific society or institution, or any public or incorporated library, may be enrolled as a member of the Association by vote of the Council by payment of the initiation fee; such society, institution or library may be represented by either the President, Curator, Director or Librarian presenting proper credentials at any meeting of the Association for which the assessment has been paid.

ART. 4. Fellows shall be elected by the Council from such of the members as are professionally engaged in science, or have by their labors aided in advancing science. The election of fellows shall be by ballot and a majority vote of the members of the Council at a designated meeting of the Council.

ART. 5. Any person paying to the Association the sum of one thousand dollars shall be classed as a Patron, and shall be entitled to all the privileges of a member and to all its publications.

ART. 6. Honorary Fellows of the Association, not exceeding three for each section, may be elected; the nominations to be made by the Council and approved by ballot in the respective sections before election by ballot in General Session. Honorary Fellows shall be entitled to all the privileges of Fellows and shall be exempt from all fees and assessments, and entitled to all publications of the Association issued after the date of their election. Corresponding Members shall consist of such scientists not residing in America as may be elected by the Council, and their number shall be limited to fifty. Corresponding Members shall be entitled to all the privileges of members and to the annual volumes of Proceedings published subsequent to their election.

ART. 7. The name of any member or fellow two years in arrears for annual dues shall be erased from the list of the Association, provided that two notices of indebtedness, at an interval of at least three months, shall have been given; and no such person shall be restored until he has paid his arrearages or has been reëlected. The Council shall have power to exclude from the Association any member or fellow, on satisfactory evidence that said member or fellow is an improper person to be connected with the Association, or has in the estimation of the Council made improper use of his membership or fellowship.

ART. 8. No member or fellow shall take part in the organization of, or hold office in, more than one section at any one meeting.

OFFICERS.

ART. 9. The officers of the Association shall be elected by ballot in General Session from the fellows, and shall consist of a President, a Vice President from each section, a Permanent Secretary, a General Secretary, a Secretary of the Council, a Treasurer, and a Secretary of each Section; these, with the exception of the Permanent Secretary, shall be elected at each meeting for the following one and, with the exception of the Treasurer and the Permanent Secretary, shall not be reëligible for the next two meetings. The term of office of Permanent Secretary shall be five years.

ART. 10. The President, or, in his absence, the senior Vice President present, shall preside at all General Sessions of the Association and at all meetings of the Council. It shall also be the duty of the President to give an address at a General Session of the Association at the meeting following that over which he presided.

ART. 11. The Vice Presidents shall be chairmen of their respective

Sections, and of their Sectional Committees, and it shall be part of their duty to give an address, each before his own section, at such time as the Council shall determine. The Vice Presidents may appoint temporary chairmen to preside over the sessions of their sections, but shall not delegate their other duties. The Vice Presidents shall have seniority in order of their continuous membership in the Association.

ART. 12. The General Secretary shall be the Secretary of all General Sessions of the Association, and shall keep a record of the business of these sessions. He shall receive the records from the Secretaries of the Sections, which, after examination, he shall transmit with his own records to the Permanent Secretary within two weeks after the adjournment of the meeting.

ART. 13. The Secretary of the Council shall keep the records of the Council. He shall give to the Secretary of each Section the titles of papers assigned to it by the Council. He shall receive proposals for membership and bring them before the Council.

ART. 14. The Permanent Secretary shall be the executive officer of the Association under the direction of the Council. He shall attend to all business not specially referred to committees nor otherwise constitutionally provided for. He shall keep an account of all business that he has transacted for the Association, and make annually a general report for publication in the annual volume of Proceedings. He shall attend to the printing and distribution of the annual volume of Proceedings, and all other printing ordered by the Association. He shall issue a circular of information to members and fellows at least three months before each meeting, and shall, in connection with the Local Committee, make all necessary arrangements for the meetings of the Association. He shall provide the Secretaries of the Association with such books and stationery as may be required for their records and business, and shall provide members and fellows with such blank forms as may be required for facilitating the business of the Association. He shall collect all assessments and admission fees, and notify members and fellows of their election, and of any arrearages. He shall receive, and bring before the Council, the titles and abstracts of papers proposed to be read before the Association. He shall keep an account of all receipts and expenditures of the Association, and report the same annually at the first meeting of the Council, and shall pay over to the Treasurer such unexpended funds as the Council may direct. He shall receive and hold in trust for the

Association all books, pamphlets and manuscripts belonging to the Association, and allow the use of the same under the provisions of the Constitution and the orders of the Council. He shall receive all communications addressed to the Association during the intervals between meetings, and properly attend to the same. He shall at each meeting report the names of fellows and members who have died since the preceding meeting. He shall be allowed a salary which shall be determined by the Council, and may employ one or more clerks at such compensation as may be agreed upon by the Council.

ART. 15. The Treasurer shall invest the funds received by him in such securities as may be directed by the Council. He shall annually present to the Council an account of the funds in his charge. No expenditure of the principal in the hands of the Treasurer shall be made without a unanimous vote of the Council, and no expenditure of the income received by the Treasurer shall be made without a two-thirds vote of the Council. The Treasurer shall give bonds for the faithful performance of his duty in such manner and sum as the Council shall from time to time direct.

ART. 16. The Secretaries of the Sections shall keep the records of their respective sections, and, at the close of the meeting, give the same, including the records of subsections, to the General Secretary. They shall also be the Secretaries of the Sectional Committees. The Secretaries shall have seniority in order of their continuous membership in the Association.

ART. 17. In case of a vacancy in the office of the President, one of the Vice Presidents shall be elected by the Council as the President of the meeting. Vacancies in the offices of Vice President, Permanent Secretary, General Secretary, Secretary of the Council, and Treasurer, shall be filled by nomination of the Council and election by ballot in General Session. A vacancy in the office of Secretary of a Section shall be filled by nomination and election by ballot in the Section.

ART. 18. The Council shall consist of the past Presidents, and the Vice Presidents of the last meeting, together with the President, the Vice Presidents, the Permanent Secretary, the General Secretary, the Secretary of the Council, the Secretaries of the Sections, and the Treasurer of the current meeting, with the addition of one fellow elected from each Section by ballot on the first day of its meeting. The members present at any regularly called meeting of the Council, provided there are at least five,

shall form a quorum for the transaction of business. The Council shall meet on the day preceding each annual meeting of the Association, and arrange the programme for the first day of the sessions. The time and place of this first meeting shall be designated by the Permanent Secretary. Unless otherwise agreed upon, regular meetings of the Council shall be held in the Council room at 9 o'clock, A.M., on each day of the meeting of the Association. Special meetings of the Council may be called at any time by the President. The Council shall be the board of supervision of the Association, and no business shall be transacted by the Association that has not first been referred to, or originated with, the Council. The Council shall receive and assign papers to the respective sections; examine and, if necessary, exclude papers; decide which papers, discussions and other proceedings shall be published, and have the general direction of the publications of the Association; manage the financial affairs of the Association; arrange the business and programmes for General Sessions; suggest subjects for discussion, investigation or reports; elect members and fellows; and receive and act upon all invitations extended to the Association and report the same at a General Session of the Association. The Council shall receive all reports of Special Committees and decide upon them, and only such shall be read in General Session as the Council shall direct. The Council shall appoint at each meeting the following sub-committees who shall act, subject to appeal to the whole Council, until their successors are appointed at the following meeting: 1, on Papers and Reports; 2, on Members; 3, on Fellows.

ART. 19. The Nominating Committee shall consist of the Council, and one member or fellow elected by each of the Sections. It shall be the duty of this Committee to meet at the call of the President and nominate the general officers for the following meeting of the Association. It shall also be the duty of this Committee to recommend the time and place for the next meeting. The Vice President and Secretary of each Section shall be recommended to the Nominating Committee by a sub-committee consisting of the Vice President, Secretary, and three members or fellows elected by the Section.

MEETINGS.

ART. 20. The Association shall hold a public meeting annually, for one week or longer, at such time and place as may be determined by vote of the Association, and the preliminary arrangements for each meeting shall be made by the Local Committee, in conjunction with the Permanent Secretary and such other persons as the Council may designate.

ART. 21. A General Session shall be held at 10 o'clock, A. M., on the first day of the meeting, and at such other times as the Council may direct.

SECTIONS AND SUBSECTIONS.

ART. 22. The Association shall be divided into Sections, namely:—A, *Mathematics and Astronomy;* B, *Physics;* C, *Chemistry, including its application to agriculture and the arts;* D, *Mechanical Science and Engineering;* E, *Geology and Geography;* F, *Zoölogy;* G, *Botany;* H, *Anthropology;* I, *Social and Economic Science.* The Council shall have power to consolidate any two or more Sections temporarily, and such consolidated Sections shall be presided over by the senior Vice President and Secretary of the Sections comprising it.

ART. 23. Immediately on the organization of a Section there shall be three fellows elected by ballot after open nomination, who, with the Vice President and Secretary and the Vice President and Secretary of the preceding meeting shall form its Sectional Committee. The Sectional Committees shall have power to fill vacancies in their own numbers. Meetings of the Sections shall not be held at the same time with a General Session.

ART. 24. The Sectional Committee of any Section may at its pleasure form one or more temporary Subsections, and may designate the officers thereof. The Secretary of a Subsection shall, at the close of the meeting, transmit his records to the Secretary of the Section.

ART. 25. A paper shall not be read in any Section or Subsection until it has been received from the Council and placed on the programme of the day by the Sectional Committee.

SECTIONAL COMMITTEES.

ART. 26. The Sectional Committees shall arrange and direct the business of their respective Sections. They shall prepare the daily programmes and give them to the Permanent Secretary for printing at the earliest moment practicable. No titles of papers shall be entered on the daily programmes except such as have passed the Council. No change shall be made in the programme for the day in a Section without the consent of the Sectional Committee. The Sectional Committees may refuse to place the title of any paper on the programme; but every such title, with the abstract of the paper or the paper itself, must be returned to the Council with the reasons why it was refused.

ART. 27. The Sectional Committees shall examine all papers and abstracts referred to the Sections, and they shall not place on the programme

any paper inconsistent with the character of the Association; and to this end they have power to call for any paper, the character of which may not be sufficiently understood from the abstract submitted.

Papers and Communications.

Art. 28. All members and fellows must forward to the Permanent Secretary, as early as possible, and when practicable before the convening of the Association, full titles of all the papers which they propose to present during the meeting, with a statement of the time that each will occupy in delivery, and also such abstracts of their contents as will give a general idea of their nature; and no title shall be referred by the Council to the Sectional Committee until an abstract of the paper or the paper itself has been received.

Art. 29. If the author of any paper be not ready at the time assigned, the title may be dropped to the bottom of the list.

Art. 30. Whenever practicable, the proceedings and discussions at General Sessions, Sections and Subsections shall be reported by professional reporters, but such reports shall not appear in print as the official reports of the Association unless revised by the Secretaries.

Printed Proceedings.

Art. 31. The Permanent Secretary shall have the Proceedings of each meeting printed in an octavo volume as soon after the meeting as possible, beginning one month after adjournment. Authors must prepare their papers or abstracts ready for the press, and these must be in the hands of the Secretaries of the Sections before the final adjournment of the meeting, otherwise only the titles will appear in the printed volume. The Council shall have power to order the printing of any paper by abstract or title only. Whenever practicable, proofs shall be forwarded to authors for revision. If any additions or substantial alterations are made by the author of a paper after its submission to the Secretary, the same shall be distinctly indicated. Illustrations must be provided for by the authors of the papers, or by a special appropriation from the Council. Immediately on publication of the volume, a copy shall be forwarded to every member and fellow of the Association who shall have paid the assessment for the meeting to which it relates, and it shall also be offered for sale by the Permanent Secretary at such price as may be determined by the Council. The Council shall also designate the institutions to which copies shall be distributed.

Local Committee.

Art. 32. The Local Committee shall consist of persons interested in the objects of the Association and residing at or near the place of the proposed meeting. It is expected that the Local Committee, assisted by the officers of the Association, will make all essential arrangements for the meeting, and issue a circular giving necessary particulars, at least one month before the meeting.

Library of the Association.

Art. 33. All books and pamphlets received by the Association shall be in the charge of the Permanent Secretary, who shall have a list of the same printed and shall furnish a copy to any member or fellow on application. Members and fellows who have paid their assessments in full shall be allowed to call for books and pamphlets, which shall be delivered to them at their expense, on their giving a receipt agreeing to make good any loss or damage and to return the same free of expense to the Secretary at the time specified in the receipt given. All books and pamphlets in circulation must be returned at each meeting. Not more than five books, including volumes, parts of volumes, and pamphlets, shall be held at one time by any member or fellow. Any book may be withheld from circulation by order of the Council. [The Library of the Association was, by vote of the Council in 1895, placed on deposit in the Library of the University of Cincinnati, Ohio. Members can obtain the use of books by writing to the Librarian of the University Library, Cincinnati, Ohio.]

Admission Fee and Assessments.

Art. 34. The admission fee for members shall be five dollars in addition to the annual assessment. On the election of any member as a fellow an additional fee of two dollars shall be paid.

Art. 35. The annual assessment for members and fellows shall be three dollars.

Art. 36. Any member or fellow who shall pay the sum of fifty dollars to the Association, at any one time, shall become a Life Member, and as such, shall be exempt from all further assessments, and shall be entitled to the Proceedings of the Association. All money thus received shall be invested as a permanent fund, the income of which, during the life of the member, shall form a part of the general fund of the Association; but, after his death, shall be used only to assist in original research, unless otherwise directed by unanimous vote of the Council.

ART. 37. All admission fees and assessments must be paid to the Permanent Secretary, who shall give proper receipts for the same.

ACCOUNTS.

ART. 38. The accounts of the Permanent Secretary and of the Treasurer shall be audited annually, by Auditors appointed by the Council.

ALTERATIONS OF THE CONSTITUTION.

ART. 39. No part of this Constitution shall be amended or annulled, without the concurrence of three-fourths of the members and fellows present in General Session, after notice given at a General Session of a preceding meeting of the Association.

MEMBERS

OF THE

AMERICAN ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE.[1]

PATRONS.[2]

THOMPSON, MRS. ELIZABETH, Stamford, Conn. (22).
LILLY, GEN. WILLIAM, Mauch Chunk, Pa. (28). (Died Dec. 1, 1893.)
HERRMAN, MRS. ESTHER, 59 West 56th St., New York, N. Y. (29).

CORRESPONDING MEMBERS.[3]

Warington, Robert, F.R.S., Rothamsted, Harpenden, England (40). **C**

MEMBERS.[4]

Abbe, Cleveland, jr., 2017 I St., Washington, D. C. (44). **E**
Abraham, Abraham, Brooklyn, N. Y. (43).
Adams, C. E., M.D., Ballentine Gymnasium, New Brunswick, N. J. (43). **F**
Aitkin, Miss Clara I., 210 Madison St., Brooklyn, N. Y. (40). **H**
Aitkin, Miss Helen J., 210 Madison St., Brooklyn, N. Y. (40). **E H**
Alden, Jno., Pacific Mills, Lawrence, Mass. (36).

[1] The numbers in parentheses indicate the meeting at which the member was elected. The black letters at the end of line indicate the sections to which members elect to belong. The Constitution requires that the names of all members two or more years in arrears shall be omitted from the list, but their names will be restored on payment of arrearages. Members not in arrears are entitled to the annual volume of Proceedings bound in paper. *The payment of ten dollars at one time entitles a member to the subsequent volumes to which he may be entitled, bound in cloth, or by the payment of twenty dollars, to such volumes bound in half morocco.*

[2] Persons contributing one thousand dollars or more to the Association are classed as Patrons, and are entitled to the privileges of members and to the publications.
The names of Patrons are to remain permanently on the list.

[3] See ARTICLE VI of the Constitution.

[4] Any Member or Fellow may become a Life Member by the payment of fifty dollars. The income of the money derived from a Life Membership is used for the general purposes of the Association during the life of the member; afterwards it is to be used to aid in original research. Life Members are exempt from the annual assessment, and are entitled to the annual volume. The names of Life Members are printed in small capitals in the regular list of Members and Fellows.

Aldis, Owen F., 230 Monadnock Block, Chicago, Ill. (41). **H**
Aldrich, Prof. William Sleeper, West Virginia Univ., Morgantown, W. Va. (43).
Allderdice, Wm. H., P. A. Engineer, U. S. Navy, care Navy Department, Washington, D. C. (33). **D**
Allen, Miss Augusta A., Germantown, Pa. (44). **G**
Allen, J. M., Hartford, Conn. (22). **D**
Allen, Prof. Thomas G., Armour Inst., Chicago, Ill. (43). **C**
Allen, W. F., 24 Park Place, New York, N. Y. (36).
Allen, Walter S., New Bedford, Mass. (39). **C I**
Alpaugh, Edwin K., Huntington, Ind. (41). **E**
Andrews, E. R., Rochester, N. Y. (41).
Angell, Geo. W. J., 44 Hudson St., New York, N. Y. (36).
Appleby, Prof. William R., Univ. of Minnesota, Minneapolis, Minn. (43). **D E**
Appleton, Rev. Edw. W., D.D., Ashbourne, Montgomery Co., Pa. (28).
Appleton, Prof. William H., Ph.D., Swarthmore College, Swarthmore, Pa. (43). **H E**
Archambault, U. E., P. O. Box 1944, Montreal, P. Q., Can. (31).
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Crehore, Mary L., care Wm. W. Crehore, Hackensack, N. J. (43). **B**
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Varney, A. L., Major of Ordnance, U. S. A., Indianapolis Arsenal, Indianapolis, Ind. (44). **H**
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Vermyné, J. J. B., M.D., 2 Orchard St., New Bedford, Mass. (29). **F**
Villard, Fanny G., Dobbs Ferry, N. Y. (36).
Vinal, W. Irving, 1106 East Capitol St., Washington, D. C. (40). **E**
Volk, Ernest, Trenton, N. J. (42). **H**
Voorhees, Chas. H., M.D., P. O. Lock Box 120, New Brunswick, N. J. (29). **F H**
Vredenburgh, Edw. H., 122 So. Fitzhugh St., Rochester, N. Y. (29).

Wagner, Frank C., care Wm. Wagner, Ann Arbor, Mich. (34). **D**
Wales, Salem H., 25 E. 55th St., New York, N. Y. (36).
Walker, Byron Edmund, Toronto, Ontario, Can. (38). **E**
Walker, George C., 228 Michigan Ave., Chicago, Ill. (17).
Walker, James, Seth Thomas Clock Co., 49 Maiden Lane, New York, N. Y. (43).
Walworth, Rev. Clarence A., 41 Chapel St., Albany, N. Y. (28). **E**
Wappenhaus, C. F. R., U. S. Weather Bureau, Indianapolis, Ind. (39). **B**
Ward, Frank A., 16-26 College Ave., Rochester, N. Y. (40).
Ward, J. Langdon, 120 Broadway, New York, N. Y. (29). **I**
Ward, Samuel B., M.D., Albany, N. Y. (29). **F C A**
Wardwell, George J., Rutland, Vt. (20). **D E**
Waring, John, Ovid, N. Y. (33). **D B**
Warner, Hulbert H. (31). **A**
Warren, Eugene C., 611 W. Main St., Louisville, Ky. (37).
Warren, Mrs. Susan E., 67 Mt. Vernon St., Boston, Mass. (29).
Warrington, James N., 127 Park Ave., Chicago, Ill. (34). **D A B**
Washburn, Prof. F. L., State Univ., Eugene, Oregon (44). **F**
Washington, Dr. Henry S., Locust, N. J. (44). **E**
WATKIS, GEO. F., 6 Somerset St., Boston, Mass. (29). **B F H E D**
Watkins, John E., C.E., National Museum, Washington, D. C. (40). **D**
Watkins, L. D., Manchester, Mich. (34). **C**
Watson, Miss C. A., Salem, Mass. (31). **D**
Watson, Elizabeth S., Weymouth, Mass. (42). **E**

Watson, Thomas A., Weymouth, Mass. (42). **E**
Watson, Thomas L., Agric. Exper. Station, Agric. and Mechan. College, Blacksburgh, Va. (42).
Watters, William, M.D., 26 So. Common St., Lynn, Mass. (40). **E G**
Watts, A. J., M.D., 1123 Bedford Ave., Brooklyn, N. Y. (43).
Waugh, D. W., M.D., 388 Clinton St., Brooklyn, N. Y. (43).
Weaver, Gerrit E. Hambleton, A.M., 300 So. 36 St., Philadelphia, Pa. (38). **G I**
Webster, Mrs. N. B., Vineland, N. J. (43).
Weed, H. E., Agricultural College, Miss. (40). **F**
Weed, J. N., 71 Water St., Newburgh, N. Y. (37). **E I**
Weeden, Hon. Joseph E., Randolph, Cattaraugus Co., N. Y. (31).
Weeks, Fred Boughton, U. S. Geol. Survey, Washington, D. C. (44). **E**
Weeks, Joseph D., Editor Amer. Manufacturer, Pittsburg, Pa. (35). **D**
Weems, J. B., Ph.D., Iowa Agric. College, Ames, Iowa (44). **C**
Weld, Prof. Laenas G., State Univ. of Iowa, Iowa City, Iowa (41). **A**
Wells, Mrs. C. F., 27 E. 21st St., New York, N. Y. (31). **H F I D B**
Wells, Samuel, 31 Pemberton Square, Boston, Mass. (24). **H**
Wells, William H., jr., 274 Ashland Ave., Chicago, Ill. (39). **E**
Wernicke, Prof. Paul, 107 E. Maxwell St., Lexington, Ky. (44). **A B**
Werum, Jno. H., Toledo, Ohio (40).
Wetzler, Jos., 203 Broadway, New York, N. Y. (36).
Wheeler, Herbert A., 2700 Pine St., St. Louis, Mo. (33). **E I**
Wheeler, T. B., M.D., 123 Metcalfe St., Montreal, P. Q., Can. (11).
Wheeler, William, C.E., Concord, Mass. (41).
Whetstone, John L., Summit Ave., Mt. Auburn, Cincinnati, Ohio (30). **D**
White, LeRoy S., Box 324, Waterbury, Conn. (23).
White, Thaddeus R., 257 W. 45th St., New York, N. Y. (42). **A**
Whitehead, John M., Att'y at Law, Janesville, Rock Co., Wis. (41). **I**
Whitfield, J. Edward, 406 Locust St., Philadelphia, Pa. (44). **C**
Whitfield, Thomas, Ph.D., 240 Wabash Ave., Chicago, Ill. (41). **C**
Whiting, Mrs. Francis, Jeffersonville, Montgomery Co., Pa. (40).
Whiting, S. B., 11 Ware St., Cambridge, Mass. (33). **D**
Whitman, Prof. Charles O., Chicago Univ., Chicago, Ill. (43). **F**
Whitney, E. R., 20 North St., Binghamton, N. Y. (41).
WHITNEY, JOSIAH D., Cambridge, Mass. (1).
Wilbor, Rev. Wm. C., Ph.D., 498 W. Ferry St., Buffalo, N. Y. (39). **F**
Wilbour, Mrs. Charlotte B., Little Compton, R. I. (28).
Wilbur, Miss F. Isabel, 1719 15th St., N. W., Washington, D. C. (42). **E H**
Wilcox, Miss Emily T., Meriden, Conn. (33). **B A**
Wilder, Alex., M.D., 5 No. 11th St., Newark, N. J. (29). **H F I**
Wilkinson, J. Henderson, 320 E. Capitol St., Washington, D. C. (35). **E**
Willard, Prof. Joseph A., State College, Centre Co., Pa. (44). **A**
Willetts, Joseph C., Skaneateles, N. Y. (29). **E F H**
Williams, H. Smith, M.D., Randall's Island, New York, N. Y. (34). **F**
Williams, Rev. Theodore B., 170 Meigs St., Rochester, N. Y. (41).

Willitts, George E., 709 S. Grand St., Lansing, Mich. (39). F
WILMARTH, MRS. HENRY D., 51 Eliot St., Jamaica Plain, Mass. (40).
Wilmot, Thos. J., Commercial Cable Co., Waterville, County Kerry, Ireland (27). B
Wilson, Prof. Andrew G., Lenox Coll., Hopkinton, Iowa (43). E
Wilson, Fred., 337 Fourth Ave., New York, N. Y. (43).
Wingate, Miss Hannah S., 2101 Fifth Ave., New York, N. Y. (31). E I
Wisser, John P., 1st Lt. 1st Artillery, U. S. A., Fort Hamilton, New York Harbor, N. Y. (33). C
Wolcott, Mrs. Henrietta L. T., Dedham, Mass. (29).
Woll, Fritz Wilhelm, Madison, Wis. (42). C
Wood, Rev. Charles, D.D., West Walnut Lane, Germantown, Pa. (43).
Wood, Mrs. Cynthia A., 171 W. 47th St., New York, N. Y. (43).
Wood, Thomas Bond, LL.D., care U. S. Legation, Lima, Peru (43).
WOOD, WALTER, 400 Chestnut St., Philadelphia, Pa. (33). F I
Woodhull, John Francis, Teachers' College, Morningside Heights, New York, N. Y. (43).
Woodland, Jesse E., Havana, N. Y. (41). F
Woodman, Dr. Durand, 80 Beaver St., New York, N. Y. (41).
Woodrow, James, Pres. South Carolina Coll., Columbia, S. C. (43).
Woods, Albert F., U. S. Dept. Agric., Washington, D. C. (43).
Woodward, Gen. John B., Pres. Brooklyn Inst. of Arts and Sciences, Brooklyn, N. Y. (43).
Woodworth, Chauncey C., Rochester, N. Y. (41). I
Woodworth, William McMichael, Ph.D., 149 Brattle St., Cambridge, Mass. (44). F
Wrenshall, John C., Baltimore, Md. (40). H
Wright, Jonathan, M.D., 73 Remsen St., Brooklyn, N. Y. (43).
Wright, Mrs. Jonathan, 73 Remsen St., Brooklyn, N. Y. (43).
Wright, John S., care Eli Lilly & Co., Indianapolis, Ind. (42). G
Wright, Rufus, 338–339 Lake St., Chicago, Ill. (37). B
Wright, S. G., La Fayette, Ind. (42). G
Wunderlich, Frederick W., M.D., 165 Remsen St., Brooklyn, N. Y. (43).
Würtele, Miss Minnie, Acton Vale, P. Q., Can. (32). H

Youmans, Mrs. Celia G., Mount Vernon, N. Y. (36).
Youmans, Vincent J., Mt. Vernon, N. Y. (43).
Yowell, Everett I., Station "C," Cincinnati, Ohio (41). A

Zeng, Miss Nellie E. de, Clyde, Wayne Co., N. Y. (41). B H
Ziegler, William, 45–49 Cedar St., New York, N. Y. (43).

[1118 PATRONS, CORRESPONDING MEMBERS AND MEMBERS.]

NOTE.—The omission of an address in the foregoing list indicates that letters directed to that last printed were returned as uncalled for. Information of the present address of the members so indicated is requested by the PERMANENT SECRETARY.

SURVIVING FOUNDERS.

[At the Brooklyn Meeting, 1894, a resolution was unanimously adopted by which all surviving founders of the Association who have maintained an interest in science were made Honorary Life Members of the Association in recognition of their pioneer work in American Science.]

Bouvé, Thomas T., Boston, Mass.
Dixwell, Epes S., Cambridge, Mass.
Green, Traill, Easton, Pa.
Hall, James, Albany, N. Y.
Hubbard, Bela, Detroit, Mich.
Hubbard, Oliver Payson, New York, N. Y.
West, Charles E., Brooklyn, N. Y.
Whitney, Josiah D., Cambridge, Mass.

HONORARY FELLOWS.[1]

ROGERS, PROF. WILLIAM B., Boston, Mass. (1). 1881. (Born Dec. 7, 1804. Died May 30, 1882.) **B E**

CHEVREUL, MICHEL EUGÈNE, Paris, France (35). 1886. (Born Aug. 31, 1786. Died April 9, 1889.) **C**

GENTH, DR. F. A., 3937 Locust St., Philadelphia, Pa. (24). 1888. (Born May 17, 1820. Died Feb. 2, 1892.) **C E**

HALL, PROF. JAMES, Albany, N. Y. (1). 1890. **E F**

GOULD, DR. BENJAMIN APTHORP, Cambridge, Mass. (2). 1895. **A B**

LEUCKART, PROF. RUDOLF, Leipsic, Saxony, Germany. (44). 1895. **F**

FELLOWS.[2]

Abbe, Professor Cleveland, Meteorologist, Weather Bureau, Dept. of Agric., Washington, D. C. (16). 1874. **B A**

Abbe, Dr. Robert, 11 W. 50th St., New York, N. Y. (36). 1892.

Abert, S. Thayer, 1108 G St., N. W., Washington, D. C. (30). 1891. **A B D E I**

Adriance, John S., 231 Broadway, New York, N.Y. (39). 1895. **C**

Alden, Prof. Geo. I., Worcester, Mass. (33). 1885. **D**

Allen, Dr. T. F., 10 E. 36th St., New York, N. Y. (35). 1887. **G**

Alvord, Major Henry E., Lewinsville, Fairfax Co., Va. (29). 1882. **I**

Alwood, Prof Wm. B., Agricultural and Mechanical College and Experiment Station, Blacksburg, Va. (39). 1891. **F**

Andrews, Prof. Launcelot W., Iowa City, Iowa (39). 1891. **C**

Anthony, Prof. Wm. A., 5 Beekman St., Temple Court, New York, N. Y. (28). 1880. **B**

Arey, Albert L., Free Academy, Rochester, N. Y. (35).

Arthur, J. C., La Fayette, Ind. (21). 1883. **G**

Ashmead, Wm. H., 1833 M St., N. W., Washington, D. C. (40). 1892. **F**

Atkinson, Edward, 31 Milk St., Boston, Mass. (29). 1881. **I D**

Atkinson, George F., Cornell Univ., Ithaca, N. Y. (39). 1892. **G**

Atwater, Prof. W. O., Wesleyan Univ., Middletown, Conn. (29). 1882. **C**

Atwell, Charles B., 1038 Sherman St., Evanston, Ill. (36). 1890. **F**

Auchincloss, Wm. S., Bryn Mawr, Pa. (29). 1886. **D A**

Avery, Elroy M., Ph.D., 657 Woodland Hills Ave., Cleveland, Ohio (37). 1889. **B**

Ayres, Prof. Brown, Tulane Univ., New Orleans, La. (31). 1885. **B**

Babcock, Prof. S. Moulton, Madison, Wis. (33). 1885. **C**

Bailey, E. H. S., Lawrence, Douglas Co., Kan. (25). 1889. **C E**

[1] See ARTICLE VI of the Constitution. [2] See ARTICLE IV of the Constitution.

*** The number in parenthesis indicates the meeting at which the member joined the Association; the date following is the year when made a Fellow; the black letters at end of line are those of the sections to which the Fellow belongs.

When the name is given in small capitals, it designates that the Fellow is also a Life Member.

Bailey, Prof. Liberty H., Cornell Univ., Ithaca, N. Y. (34). 1887. G

Baker, Frank, M.D., 1315 Corcoran St., Washington, D. C. (31). 1886. F H

Baker, Marcus, U. S. Geological Survey, Washington, D. C. (30). 1882. A

Ballard, Harlan H., 50 South St., Pittsfield, Mass. (31). 1891. E F

BARKER, PROF. G. F., 3909 Locust St., Philadelphia, Pa. (18). 1875. B C

Barnard, Edward E., care Yerkes Observatory, Lake Geneva, Williams Bay P. O., Wis. (26). 1883. A

Barnes, Prof. Chas. R., Madison, Wis. (33). 1885. G

Bartlett, Prof. Edwin J., Dartmouth College, Hanover, N. H. (28). 1883. C

Bartlett, John R., Commander U. S. N., Lonsdale, R. I. (30). 1882. E B

Bartley, Elias H., M.D., 21 Lafayette Ave., Brooklyn, N. Y. (33). 1894. C

Barus, Carl, Ph.D., 2808 N St., N. W., Washington, D. C. (33). 1887. B

Baskerville, Charles, Univ. of North Carolina, Chapel Hill, N. C. (41). 1894. C

Bassett, Homer F., Waterbury, Conn. (23). 1874. F

Bates, Henry H, Ph.D., U. S. Patent Office, Washington, D. C. (33). 1887. B A C D

Battle, Herbert B., Ph.D., Director N. C. Agric. Exper. Station, Raleigh, N. C. (33). 1889. C

Bauer, Louis A., Ph D., University of Chicago, Chicago, Ill. (40). 1892. A

Bausch, Edward, P. O. Drawer 1033, Rochester, N. Y. (26). 1883. A B C F

Beal, Prof. Wm. James, Agricultural College, Ingham Co., Mich. (17). 1880. G

Beardsley, Prof. Arthur, Swarthmore College, Swarthmore, Del. Co., Pa. (33). 1885. D

Beauchamp, Rev. Wm. M., Baldwinsville, N. Y. (34). 1886. H

Becker, Dr. Geo. F., U. S. Geol. Survey, Washington, D. C. (36). 1890. E

Bedell, Frederick, Ph.D., Cornell Univ., Ithaca, N. Y. (41). 1894. B A

Bell, Alex. Melville, 1525 35th St., Washington, D. C. (31). 1885. H

Bell, Robert, M.D., Ass't Director Geological Survey, Ottawa, Ontario, Can. (38). 1889. E F

Beman, Wooster W., 19 So. 5th St., Ann Arbor, Mich. (34). 1886. A

BENJAMIN, MARCUS, 589 West End Ave., New York, N. Y. (27). 1887. C

Benjamin, Rev. Raphael, M.A., 28 E. 76 St., New York, N. Y. (34). 1887. E F G H

Bessey, Prof. Charles E., Univ. of Nebraska, Lincoln, Neb. (21). 1880. G

Bethune, Rev. C. J. S., Trinity College School, Pt. Hope, Ont., Can. (18). 1875. F

Beyer, Dr. Henry G., U. S. N., U. S. Naval Acad., Annapolis, Md. (31). 1884. F

Bickmore, Prof. Albert S., American Museum of Natural History, 8th Ave. and 77th St., Central Park, New York, N. Y. (17). 1880. H

Bigelow, Prof. Frank H., U. S. Weather Bureau, Washington, D. C. (36). 1888. **A**

Billings, John S., Surgeon U. S. A., Surg. General's Office, Washington, D. C. (32). 1883. **F H**

BIXBY, W. H., Major, Corps of Engineers, U. S. A., Engineer 4th L. H. Dist., Room 20, 4th Floor, P. O. Building, Philadelphia, Pa. (34). 1892. **D**

Blackham, George E., M.D., Dunkirk, N. Y. (25). 1883. **F**

Blake, Clarence J., M.D., 226 Marlborough St., Boston, Mass. (24). 1877. **B F**

Blake, Francis, Auburndale, Mass. (28). 1874. **B A**

Blue, Archibald, Director of the Bureau of Mines, Toronto, Ontario, Can. (35). 1890. **I**

Boardman, Mrs. William D., 38 Kenilworth St., Roxbury, Mass. (28). 1885. **E H**

Boas, Dr. Franz, Amer. Museum Natural History, Central Park, New York, N. Y. (36). 1888. **H**

Boerner, Chas. G., Vevay, Switzerland Co., Ind. (29). 1886. **A B E**

Bolley, Henry L., North Dakota Exper. Station, Fargo, North Dakota (39). 1892. **G**

BOLTON, DR. H. CARRINGTON, Cosmos Club, Washington, D. C. (17). 1875. **C**

Bond, Geo. M., care of The Pratt & Whitney Co., Hartford, Conn. (33). 1885. **D**

Booth, Miss Mary A., 32 Byers St., Springfield, Mass. 1894. **F I G**

Bourke, John G., Capt. 3d Cavalry, U. S. A., War Dept., Washington D. C. (33). 1885. **H**

BOUVÉ, THOS. T., Boston Soc. Nat. Hist., Boston, Mass. (1). 1875. **E**

Bowditch, Prof. H. P., Jamaica Plain, Mass. (28). 1880. **F B H**

Bowser, Prof. E. A., Rutgers College, New Brunswick, N. J. (28). 1881.

Brackett, Prof. C. F., College of New Jersey, Princeton, N. J. (19). 1875. **B**

Brackett, Richard N., Associate Prof. of Chemistry, Clemson Agric. College, Fort Hill, S. C. (37). **C E**

Bradford, Royal B., Commander U. S. N., care Navy Dept, Washington, D. C. (31). 1891. **B D**

Branner, Prof. John C., Stanford University, Cal. (34). 1886. **E F**

Brashear, Jno. A., Allegheny, Pa. (33). 1885. **A B D**

Brewer, Prof. Wm. H., New Haven, Conn. (20). 1875. **E F I**

Brinton, D. G., M.D., Media, Pa. (33). 1885. **H**

Bristol, Wm. H., Stevens Institute, Hoboken, N. J. (36). 1894. **A B D**

Britton, Dr. N. L., Columbia College, New York, N. Y. (29). 1882. **G E**

Broadhead, Prof. Garland Carr, University, Columbia, Mo. (27). 1879. **E**

Brooks, Wm. R., Box 714, Geneva, N. Y. (35). 1886. **A B D G**

Brown, Robert, care of Yale College Observatory, New Haven, Conn. (11). 1874.

Brown, Mrs. Robert, New Haven, Conn. (17). 1874.

Brühl, Gustav, cor. John and Hopkins Sts., Cincinnati, Ohio (28). 1886. **H**
Brush, Charles F., Brush Electric Light Co., Cleveland, Ohio (35). 1886. **B**
BRUSH, PROF. GEORGE J., Yale College, New Haven, Conn. (4). 1874. **C E**
Buckhout, W. A., State College, Centre Co., Pa. (20). 1881. **F**
Burgess, Dr. Thomas J. W., Med. Sup't, Protestant Hospital for the Insane, Montreal, P. Q., Can. (38). 1889. **G**
Burr, Prof. William H., School of Mines, 41 East 49th St., New York, N. Y. (31). 1883.
Butler, A. W., Brookville, Franklin Co., Ind. (30). 1885. **F H**

Caldwell, Prof. Geo. C., Cornell University, Ithaca, N. Y. (23). 1875. **C**
Calvin, Prof. Samuel, State Univ. of Iowa, Iowa City, Iowa (37). 1889. **E F**
Campbell, Prof. Douglas H., Menlo Park, Cal. (34). 1888. **G**
Canby, William M., 1101 Delaware Avenue, Wilmington, Del. (17). 1878. **G**
Carhart, Prof. Henry S., University of Michigan, Ann Arbor, Mich. (29). 1881. **B**
Carleton, M. A., Dep't Agric., Div. of Vegetable Pathology, Washington, D. C. (42) 1894. **G**
Carpenter, Louis G., Agricultural College, Fort Collins, Col. (32). 1889. **A B**
Carpenter, Capt. W. L., U. S. A., care Adjutant General, Washington, D. C. (24). 1877. **F E**
Carter, James Madison G., M.D., Waukegan, Ill. (39). 1895. **F**
Carus, Paul, Ph.D., La Salle, Ill. (40). 1895. **H**
Casey, Thomas L., 1419 K St., N. W., Washington, D. C. (38). 1892. **F**
Catlin, Charles A., 133 Hope St., Providence, R. I. (33). 1895. **C**
Chamberlain, Alexander F., Clark Univ., Worcester, Mass. (38). 1890. **H**
Chamberlin, T. C., 5041 Madison Ave., Chicago, Ill. (21). 1877. **E B F H**
Chandler, Prof. C. F., School of Mines, Columbia Coll., East 49th St., cor. 4th Ave., New York, N. Y. (19). 1875. **C**
Chandler, Prof. Charles Henry, Ripon, Wis. (28). 1883. **A B**
Chandler, Seth C., 16 Craigie St., Cambridge, Mass. (29). 1882. **A**
Chandler, Prof. W. H., South Bethlehem, Pa. (19). 1894. **C**
Chanute, O., 413 E. Huron St., Chicago, Ill. (17). 1877. **D I**
Charbonnier, Prof. L. H., University of Georgia, Athens, Ga. (26). 1894. **A B D**
Cheney, Lellen Sterling, 1081 W. Johnson St., Madison, Wis. (42). 1894. **G**
Chester, Prof. Albert H., Rutgers College, New Brunswick, N. J. (29). 1882. **C F**
Christie, James, Pencoyd, Pa. (33). 1894. **D**
Christy, Prof. Samuel B., Box 41, Berkeley, Cal. (35). 1894. **D**
Chute, Horatio N., Ann Arbor, Mich. (34). 1889. **B C A**
Clapp, Miss Cornelia M., Mt. Holyoke College, South Hadley, Mass. (31). 1883. **F**

Clark, Alvan G., Cambridgeport, Mass. (28). 1880. **A B**
Clark, Prof. John E., 445 Orange St., New Haven, Conn. (17). 1875. **A**
Clark, Wm. Bullock, Ph.D., Johns Hopkins Univ., Baltimore, Md. (37). 1891. **E**
Clarke, Prof. F. W., U. S. Geological Survey, Washington, D. C. (18). 1874. **C**
Clarke, Robert, Cincinnati, Ohio. (30). 1895. **H**
Claypole, Prof. Edw. W., 603 Buchtel Ave., Akron, Ohio (30). 1882. **E F**
Cloud, John W., 974 Rookery, Chicago, Ill. (28). 1886. **A B D**
Coffin, Prof. Selden J., Lafayette College, Easton, Pa. (22). 1874. **A I**
Cogswell, W. B., Syracuse, N. Y. (33). 1891. **D**
Colburn, Richard T., Elizabeth, N. J. (31). 1894. **I F H**
Cole, Prof. Alfred D., Denison Univ., Granville, Ohio (39). 1891. **B C**
Collin, Prof. Alonzo, Cornell College, Mount Vernon, Iowa (21). 1891. **B C**
Collingwood, Francis, Elizabeth, N. J. (36). 1888. **D**
Colvin, Verplanck, Supt. N. Y. State Adirondack Survey, Albany, N. Y. (28). 1880. **E**
Comstock, Prof. Geo. C., Washburn Observ., Univ. of Wisconsin, Madison, Wis. (34). 1887. **A**
Comstock, J. Henry, 48 East Ave., Ithaca, N. Y. (28). 1882. **F**
Comstock, Milton L., 641 Academy St., Galesburg, Ill. (21). 1874. **A**
Comstock, Prof. Theo. B., President Univ. of Arizona, Tucson, Arizona (24). 1877. **D E B**
Conant, Prof. L. L., Polytechnic Inst., Worcester, Mass. (39). 1892. **A**
Cook, Prof. A. J., Pomona College, Claremont, Cal. (24). 1880. **F**
Cook, Prof. Chas. Sumner, Santa Barbara, Cal. (36). 1889. **B**
Cook, Prof. Orator F., Huntington, N. Y. (40). 1892. **G**
Cooley, Prof. Le Roy C., Vassar College, Poughkeepsie, N. Y. (19). 1880. **B C**
Cooley, Prof. Mortimer E., Univ. of Michigan, Ann Arbor, Mich. (33). 1885. **D**
Cope, Prof. Edward D., 2102 Pine St., Philadelphia, Pa. (17). 1875. **F E**
Corthell, Elmer L., 71 Broadway, New York, N. Y. (34). 1886. **D I E**
Coulter, Prof. John M., Lake Forest, Ill. (32). 1884. **G**
Coville, Frederick V., Dept. of Agric., Washington, D. C. (35). 1890. **G**
Cox, Hon. Jacob D., Gilman Ave., Mt. Auburn, Cincinnati, Ohio (30). 1881. **F**
Cragin, Francis W., Colorado College, Colorado Springs, Col. (29). 1890. **F E H**
Craighill, Gen. Wm. P., U. S. A., War Dept., Washington, D. C. (37). 1892. **D**
Crampton, Chas. A., M.D., Office of Internal Revenue, Treasury Department, Washington, D. C. (36). 1887. **C**
Crandall, Prof. Charles S., Fort Collins, Col. (40). 1894.
Crawford, Prof. Morris B., Middletown, Conn. (30). 1889. **B**
Crockett, Charles W., Rensselaer Polytechnic Inst., Troy, N. Y. (39). 1894. **A D**

Cross, Prof. Chas. R., Mass. Institute Technology, Boston, Mass. (29). 1880. B
Crozier, A. A., Ann Arbor, Mich. (36). 1891. G
Culin, Stewart, Univ. of Pa., Philadelphia, Pa. (33). 1890. H
Cummings, John, Cummingsville, Woburn, Mass. (18). 1890. F
Curtman, Dr. Charles O., 3718 North 9th St., St. Louis, Mo. (39). 1895. C
Cushing, Frank H., Bureau of Ethnology, Washington, D. C. (40). 1893. H
Cushing, Henry Platt, Adelbert College, Cleveland, Ohio (33). 1888. E

Dall, William H., Smithsonian Institution, Washington, D. C. (18). 1874. H F
Dana, Edward Salisbury, New Haven, Conn. (23). 1875. B E
Dancy, Frank B., A.B., Old Dominion. Guano Co., Norfolk, Va. (33). 1890. C
Daniel, John, Vanderbilt Univ., Nashville, Tenn. (38). 1894. B
Darton, Nelson H., U. S. Geol. Survey, Washington, D. C. (37). 1893.
Davidson, Prof. Geo., U. S. Coast and Geodetic Survey, San Francisco, Cal. (29). 1881. A B D
Davis, Wm. Morris, Cambridge, Mass. (33). 1885. E B
Dawson, Geo. M., S.S.C., F.G.S., Geol. Survey, Ottawa, Ontario, Can. (38). 1895. E
Dawson, Sir William, Principal McGill College, Montreal, Can. (10). 1875. E
Day, David F., Buffalo, N. Y. (35). 1887. G
Day, Fisk H., M.D., 309 Sycamore St., Lansing, Mich. (20). 1874. E H F
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Dexter, Julius, Cincinnati. Ohio (30).
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Doolittle, Prof. C. L., South Bethlehem, Pa. (25). 1885. A
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Harris, Gilbert D., Ithaca, N. Y. (37). 1893.
Harris, Uriah R., Lieutenant U. S. N., U. S. S. Ranger, care Navy Pay Office, San Francisco, Cal. (34). 1886. **A**
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Hill, David J., Pres. Univ. of Rochester, Rochester, N. Y. (41). 1895. **H I**
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HITCHCOCK, PROF. CHARLES H., Hanover, N. H. (11). 1874. **E**
Hobbs, William Herbert, Ph.D., Madison, Wis. (41). 1893. **E**
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Holway, E. W. D., Decorah, Iowa (33). 1890. **G**

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Hough, Prof. G. W., Northwestern Univ., Evanston, Ill. (15). 1874. **A**

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Metcalf, William, Pittsburgh, Pa. (33). 1894. **D**

Michael, Mrs. Helen Abbott, Torwood, Bonchurch, Isle of Wight, England (33). 1885. **C F**

Miles, Prof. Manly, Lansing, Mich. (29). 1890. **F I**

Miller, Wm. S., M.D., 923 W. Johnson St., Madison, Wis. (42). 1894. **F**

Mills, James, M.A., Guelph, Ontario, Can. (31). 1895. **I C**

Mills, Prof. Wesley, McGill College, Montreal, P. Q., Can. (31). 1886. **F H**

Millspaugh, C. F., M.D., Field Columbian Museum, Chicago, Ill. (40). 1892. **G**

Minot, Dr. Charles Sedgwick, Harvard Medical School, Back Bay, Boston, Mass. (28). 1880. **F**

Minot, Francis, M.D., 65 Marlborough St., Boston, Mass. (29). 1884.

Mixter, Prof. Wm. G., New Haven, Conn. (30). 1882. **C**

Mohr, Dr. Charles, Mobile, Ala. (40). 1895. **G**

Moler, Geo. S., 106 University Ave., Ithaca, N. Y. (38). 1892.

Moody, Robert O., M.D., Fair Haven Heights, New Haven, Conn. (35). 1892. **F**

Mooney, James, Bureau of Ethnology, Washington, D. C. (38). 1890. **H**

Moore, E. Hastings, The Univ. of Chicago, Chicago, Ill. (39). 1891. **A**

Moore, Prof. J. W., M.D., Lafayette College, Easton, Pa. (22). 1874. **B D A**

Moore, Veranus A., M.D., Bureau of Animal Industry, Dept. of Agric., Washington, D. C. (40). 1892. **F**

Moorehead, Warren K., Xenia, Ohio (38). 1890. **H**

Moreland, Prof. S. T., Lexington, Va. (33). 1894. **B D**

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Morse, Prof. E. S., Salem, Mass. (18). 1874. **F H**

Morton, H., Stevens Institute Technology, Hoboken, N. J. (18). 1875. **B C**

Moser, Lieut. Comd'r Jeff. F., U. S. N., Hydrographic Inspector, C. and G. Survey, Washington, D. C. (28). 1889. **E**

Moses, Prof. Thomas F., Urbana University, Urbana, Ohio (25). 1883. **H F**

Munroe, Prof. C. E., Columbian Univ., Washington, D. C. (22). 1874. **C**
Murdoch, John, Rock, Plymouth Co., Mass. (29). 1886. **F H**
Murtfeldt, Miss Mary E., Kirkwood, Mo. (27). 1881. **F**
Myers, John A., Agric. Exper. Station, Morgantown, W. Va. (30). 1889. **C**

Nagle, Prof. James C., A. and M. Coll., College Station, Texas (40). 1893. **D B**
Nason, Frank L., 5 Union St., New Brunswick, N. J. (36). 1888. **E**
Nef, J. U., Univ. of Chicago, Chicago, Ill. (39). 1891. **C**
Nelson, Prof. A. B., Centre College, Danville, Ky. (30). 1882. **A B D**
Newcomb, Prof. S., Navy Dep't, Washington, D. C. (13). 1874. **A B**
Newell, F. H., U. S. Geol. Survey, Washington, D. C. (40). 1893.
Newell, William Wells, Editor Journal American Folk Lore, Cambridge, Mass. (41). 1893. **H**
Newton, Hubert A., New Haven, Conn. (6). 1874. **A**
Nichols, Ernest Fox, Hamilton, N. Y. (41). 1893. **B**
Nichols, E. L., Ph.D., Cornell Univ., Ithaca, N. Y. (28). 1881. **B C**
Nicholson, Prof. H. H., Box 675, Lincoln, Neb. (36). 1888.
Niles, Prof. W. H., Cambridge, Mass. (16). 1874.
Nipher, Prof. F. E., Washington Univ., St. Louis, Mo. (24). 1876. **B**
NORTON, PROF. THOMAS H., Univ. of Cincinnati, Cincinnati, Ohio (35). 1887. **C**
Noyes, Prof. Wm. A., Rose Polytechnic Inst., Terre Haute, Ind. (32). 1885. **C**
Nuttall, Mrs. Zelia, care Peabody Museum, Cambridge, Mass. (35). 1887. **H**
Nutting, Prof. Charles C., State Univ. of Iowa, Iowa City, Iowa (40). 1892. **F**

Ogden, Herbert G., U. S. Coast and G. Survey, Washington, D. C. (38). 1891. **E**
Ordway, Prof. John M., Tulane Univ., New Orleans, La. (9). 1875. **C**
Orndorff, Dr. William Ridgely, Cornell Univ., Ithaca, N. Y. (41). 1893. **C**
Orr, William, Jr., 133 Catharine St., Springfield, Mass. (39). 1895. **F B**
Orton, Prof. Edward, President Ohio Agricultural and Mechanical College, Columbus, Ohio (19). 1875. **E**
Osborn, Henry F., Columbia College, New York, N. Y. (29). 1883. **F**
Osborn, Herbert, Ames, Iowa (32). 1884. **F**
Osmond, Prof. I. Thornton, State College, Centre Co., Pa. (33). 1889. **B A C**

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Pammel, Prof. L. H., Iowa Agricultural College, Ames, Iowa (39). 1892.
Parke, John G., Gen. U. S. A., 16 Lafayette Square, Washington, D. C. (29). 1881. **D**

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Patterson, Harry J., College Park, Prince George's Co., Md. (36). 1890. **C**
Paul, Prof. Henry M., U. S. Naval Observatory, Washington, D. C. (33). 1885. **A B**
Peabody, Selim H., 4200 Berkeley Ave., Chicago, Ill. (17). 1885. **D B F**
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Pedrick, Wm. R., Lawrence, Mass. (22). 1875.
Peet, Rev. Stephen D., Good Hope, Ill. (24). 1881. **H**
Penrose, Dr. R. A. F., 1331 Spruce St., Philadelphia, Pa. (38). 1890. **E**
Perkins, Prof. George H., Burlington, Vt. (17). 1882. **H F E**
Peter, Alfred M., 171 Rose St., Lexington, Ky. (29). 1890. **C**
Peters, Edw. T., P. O. Box 265, Washington, D. C. (33). 1889. **I**
Pettee, Prof. Wm. H., 52 Thompson St., Ann Arbor, Mich. (24). 1875. **E**
Phillips, Prof. A. W., New Haven, Conn. (24). 1879.
Phillips, Prof. Francis C., 59 Sherman Ave., Allegheny, Pa. (36). 1889. **C**
Phillips, Dr. Wm. A., Evanston, Ill. (41). 1895. **H**
Phippen, Geo. D., Salem, Mass. (18). 1874. **G**
Pickering, Prof. E. C., Director of Observatory, Cambridge, Mass. (18). 1875. **A B**
Pierce, Perry Benj., U. S. Patent Office, Washington, D. C. (40). 1895. **H**
Pillsbury, Prof. John H., Smith College, Northampton, Mass. (23). 1885. **F H**
Platt, Franklin, Ass't Geologist, 2nd Geol. Survey of Pa., 1319 Walnut St., Philadelphia, Pa. (27). 1882. **E**
Pohlman, Dr. Julius, Buffalo, N. Y. (32). 1884. **E F**
Porter, Thos. C., LL.D., Lafayette College, Easton, Pa. (33). 1887. **G**
Powell, Major J. W., Washington, D. C. (23). 1875. **E H**
Power, Prof. Frederick B., 225 Gregory Ave., Passaic, N. J. (31). 1887. **C**
Prentiss, Prof. A. N., Cornell Univ., Ithaca, N. Y. (35). 1887. **G**
Prentiss, D. Webster, M.D., 1101 14th St., N. W., Washington, D. C. (29). 1882. **F**
Prentiss, Robert W., Prof. of Mathematics and Astronomy, Rutgers College, New Brunswick, N. J. (40). 1891. **A**
Prescott, Prof. Albert B., Ann Arbor, Mich. (23). 1875. **C**
Prosser, Charles S., Prof. of Geology, Union Coll., Schenectady, N. Y. (33). 1891. **E F**
Pulsifer, Wm. H., Newton Centre, Mass. (26). 1879. **A H**
Pumpelly, Prof. Raphael, U. S. Geological Survey, Newport, R. I. (17). 1875. **E I**
Putnam, Prof. F. W., Curator Peabody Museum American Archæology and Ethnology, Cambridge, Mass.; Curator Dept. Anthropology, Amer. Museum Nat. History, Central Park, New York, N. Y. (Address as Permanent Secretary A. A. A. S., Salem, Mass.) (10). 1874. **H**
Pynchon, Rev. T. R., Trinity College, Hartford, Conn. (23). 1875.

Rathbun, Richard, U. S. Nat'l Museum, Washington, D. C. (40). 1892. **F**
Rau, Eugene A., Bethlehem, Pa. (33). 1890. **G**
Raymond, Rossiter W., 13 Burling Slip, New York, N. Y. (15). 1875. **E I**
Rees, Prof. John K., Columbia College, New York, N. Y. (26). 1878. **A E B**
Reese, Charles L., The Citadel, Charleston, S. C. (39). 1892. **C**
Reese, Jacob, 400 Chestnut St., Philadelphia, Pa. (33). 1891. **D B**
Reid, Harry Fielding, Johns Hopkins Univ., Baltimore, Md. (36). 1893. **B**
Remsen, Prof. Ira, Johns Hopkins Univ., Baltimore, Md. (22). 1875. **C**
Rice, Prof. Wm. North, Wesleyan University, Middletown, Conn. (18). 1874. **E F**
Richards, Prof. Charles B., 137 Edwards St., New Haven, Conn. (33). 1885. **D**
Richards, Edgar, 1621 H St., Washington, D. C. (31). 1886. **C**
Richards, Prof. Robert H., Mass. Inst. Tech., Back Bay, Boston, Mass. (22). 1875. **D**
Richards, Mrs. Robert H., Prof. Mass. Inst. of Tech., Back Bay, Boston, Mass. (23). 1878. **C**
Richardson, Clifford, Sup't of Tests, Barber Asphalt Paving Co., Long Island City, N. Y. (30). 1884. **C**
Ricketts, Prof. Palmer C., 17 1st St., Troy, N. Y. (33). 1887. **D A**
Ricketts, Prof. Pierre de Peyster, 104 John St., New York, N. Y. (26). 1880. **C D E**
Risteen, Allen D., Hartford, Conn. (38). 1890. **A B D**
Ritchie, E. S., Newton Highlands, Mass. (10). 1877. **B**
Ritter, W. F. McK., P. O. Box 50, Milton, Pa. (40). 1893.
Robinson, Benjamin Lincoln, Curator Harvard Herbarium, Cambridge, Mass. (41). 1893. **G**
Robinson, Prof. Franklin C., Bowdoin College, Brunswick, Me. (29). 1889. **C D**
Robinson, Prof. S. W., 1353 Highland St., Columbus, Ohio (30). 1883. **D B A**
Rockwell, Gen. Alfred P., Manchester, Mass. (10). 1882. **E**
Rockwell, Chas. H., Box 293, Tarrytown, N. Y. (28). 1883. **A D**
Rockwood, Prof. Charles G., jr., College of New Jersey, Princeton, N. J. (20). 1874. **A E B D**
Rogers, Prof. W. A., Colby Univ., Waterville, Me. (15). 1875. **A B D**
Rominger, Dr. Carl, Ann Arbor, Mich. (21). 1879. **E**
Rood, Prof. O. N., Columbia College, New York, N. Y. (14). 1875. **B**
Rosa, Edward Bennett, Prof. of Physics, Wesleyan Univ., Middletown, Conn. (39). 1892. **A B**
Ross, Prof. Edward A., Stanford, Cal. (41). 1894. **I**
Ross, Waldo O., 1 Chestnut St., Boston, Mass. (29). 1882.
Rowland, Prof. Henry A., Baltimore, Md. (29). 1880. **B**
Rowlee, W. W., Cornell Univ., Ithaca, N. Y. (41). 1894. **G**

Runkle, Prof. J. D., Mass. Institute of Technology, Boston, Mass. (2). 1875. **A D**

Rusby, Henry H., M.D., College of Pharmacy, 211 E. 23d St., New York, N. Y. (36). 1890. **G**

Russell, Prof. H. L., Univ. of Wisconsin, Madison, Wis. (41). 1894. **G**

Russell, I. C., Univ. of Mich., Ann Arbor, Mich. (25). 1882. **E**

Ryan, Harris J., Cornell Univ., Ithaca, N. Y. (38). 1890. **B**

Sadtler, Sam'l P., 1042 Drexel Building, Philadelphia, Pa. (22). 1875. **C**

Saegmuller, G. N., 132 Maryland Ave., S. W., Washington, D. C. (38). 1891. **A B**

Safford, Dr. James M., Nashville, Tenn. (6). 1875. **E C F**

Safford, Prof. Truman H., Williamstown, Mass. (41). 1892. **A**

Salisbury, Prof. R. D., Chicago Univ., Chicago, Ill. (37). 1890. **B E**

Salmon, Daniel E., Dep't of Agric., Washington, D. C. (31). 1885. **F**

Sampson, Commander W. T., U. S. N., Navy Dept., Washington, D. C. (25). 1881. **B A**

Saunders, Prof. Charles E., 32 St. Mary St., Toronto, Ontario, Can. (41). 1895. **C**

Saunders, William, Director Canadian Experimental Farms, Ottawa, Ontario, Can. (17). 1874. **F**

Saville, Marshall H., Amer. Mus. Nat. Hist., Central Park, New York, N. Y. (39). 1892. **H**

SCHAEBERLE, J. M., Astronomer in the Lick Observatory, San José, Cal. (34). 1886. **A**

Schanck, Prof. J. Stillwell, Princeton, New Jersey (4). 1882. **C B H**

Schott, Charles A., U. S. Coast and Geodetic Survey Office, Washington, D. C. (8). 1874. **A**

Schurman, Jacob G., Pres. Cornell Univ., Ithaca, N.Y. (41). 1895. **H**

Schwarz, E. A., 230 New Jersey Ave., Washington, D. C. (29). 1895. **F**

Schweinitz, Dr. E. A. de, Dep't of Agriculture, Washington, D. C. (36). 1889. **C**

Schweitzer, Prof. Paul, State University of Missouri, Columbia, Mo. (24). 1877. **C B**

Scovell, M. A., Director Kentucky Agricultural Experiment Station, Lexington, Ky. (35). 1887.

Scribner, F. Lamson, Director Tenn. Agricultural Exper. Station, Knoxville, Tenn. (34). 1887. **G**

SCUDDER, SAMUEL H., Cambridge, Mass. (13). 1874. **F**

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Searle, Prof. Geo. M., Catholic Univ., Washington, D. C. (39). 1891. **A**

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Seymour, Arthur Bliss, Cambridge, Mass. (36). 1890. **G**

Sharples, Stephen P., 13 Broad St., Boston, Mass. (29). 1884. **C**

Sheldon, Samuel, A.M., Ph.D., Polytechnic Inst. Brooklyn, N. Y. (42). 1894. B
Shelton, Prof. Edward M., Dep't of Agric., Brisbane, Queensland, Australia (32). 1892. F
Shimer, Porter W., E.M., Easton, Pa. (38). 1889. C
Shufeldt, Dr. R. W., Smithsonian Institution, Washington, D. C. (40). 1892. F
Shutt, Frank T., M.A., F.E.C., F.C.S., Chief Chemist Canadian Experimental Farm, Ottawa, Ontario, Can. (38). 1889. C
Sias, Solomon, M.D., Schoharie, Schoharie Co., N. Y. (10). 1874.
Sigsbee, Chas. D., Com'd'r U. S. N., U. S. Hydrographic Office, Washington, D. C. (28). 1882. D E
Silliman, Prof. Justus M., Lafayette Coll., Easton, Pa. (19). 1874. D E
Simon, Dr. Wm., 1348 Block St., Baltimore, Md. (29). 1895. C
Skilton, James A., 115 Broardway, New York, N. Y. (43). 1895. I
Skinner, Aaron N., U. S. Naval Observ., Washington, D. C. (40). 1893. A
Skinner, Joseph J., Massachusetts Inst. Technology, Boston, Mass. (28). 1880. B
Smith, Alex., Ph.D., The Univ. of Chicago, Chicago, Ill. (40). 1892. C
Smith, Prof. Chas. J., 35 Adelbert St., Cleveland, Ohio (32). 1885. A B
Smith, Prof. Edgar F., Univ. of Penn., Philadelphia, Pa. (33). 1891. C
Smith, Edwin, Rockville, Montgomery Co., Md. (30). 1882. A B
Smith, Prof. Erastus G., Beloit College, Beloit, Wis. (34). 1887. C
Smith, Erwin F., Dep't of Agric., Washington, D. C. (34). 1890. G
Smith, Prof. Eugene A., University, Ala. (20). 1877. E C
Smith, James Perrin, Ph.D., Ass't Prof. of Paleontology, Leland Stanford Junior Univ., Palo Alto, Cal. (37). 1894. C E
Smith, John B., Professor of Entomology, Rutgers College, New Brunswick, N. J. (32). 1884. F
SMITH, QUINTIUS C., M.D., No. 617 Colo. St., Austin, Texas (26). 1881. F
Smith, Dr. Theobald, 41 Orchard St., Jamaica Plain, Mass. (35). 1887. F
Smock, Prof. John Conover, Trenton, N. J. (23). 1879. E
Smyth, C. H., jr., Clinton, N. Y. (38). 1894. E
Snow, Prof. Benj. W., Madison, Wis. (35). 1889. B
Snow, Prof. F. H., Lawrence, Kan. (29). 1881. F E
Snow, Julia W., La Salle, Ill. (39). 1892. F
Snyder, Henry, B.Sc., Miami Univ., Oxford, Ohio (30). 1888. B C
Snyder, Prof. Monroe B., High School Observatory, Philadelphia, Pa. (24). 1882. A B
Soule, R. H., Roanoke, Va. (33). 1886. D
Spencer, Prof. J. William, 1751 18th St., Washington, D. C. (28). 1882. E
SPENZER JOHN G., M.D., 370 Central Ave., Cleveland, Ohio (37). 1895. C
Springer, Dr. Alfred, Box 621, Cincinnati, Ohio (24). 1880. C
Starr, Frederick, Ph.D., Prof. Univ. of Chicago, Chicago, Ill. (36). 1892. H E

Stearns, Robert E. C., Shaffer House, 525 Sand St., Los Angeles, Cal. (18). 1874. **F**

Stedman, John M., Prof. of Entomology, Univ. of the State of Missouri, Columbia, Mo. (40). 1892. **F**

Steinmetz, Chas. Proteus, General Electric Co., Lynn, Mass. (40). 1895. **B**

Stejneger, Leonhard, Curator Dept. of Reptiles, National Museum, Washington, D. C. (40). 1892. **F**

STEPHENS, W. HUDSON, Lowville, N. Y. (18). 1874. **E H**

Sternberg, George M., M.D., LL.D., Surgeon General U. S. A., War Dep't, Washington, D. C. (24). 1880. **F**

Stevens, Prof. W. LeConte, Rensselaer Polytechnic Inst., Troy, N. Y. (29). 1882. **B**

Stevenson, Mrs. Cornelius, 237 So. 21st St., Philadelphia, Pa. (33). 1895.

Stevenson, Prof. John J., Univ. of New York, New York, N. Y. (36). 1888.

Stevenson, Mrs. Matilda C., Bureau of Ethnology, Washington, D. C. (41). 1893. **H**

Stieglitz, Dr. Julius, Univ. of Chicago, Chicago, Ill. (39). 1895. **C**

Stiles, Dr. Chas. W., Dept. of Agric., Washington, D. C. (40). 1892. **F**

Stoddard, Prof. John T., Smith College, Northampton, Mass. (35). 1889. **B C**

Stokes, Henry Newlin, Ph.D., U. S. Geol. Survey, Washington, D. C. (38). 1891. **C E**

Stone, Ormond, Director Leander McCormick Observatory, University of Virginia, Va. (24). 1876. **A**

Stone, Prof. Winthrop E., Purdue Univ., La Fayette, Ind. (39). 1891. **C**

Story, Prof. Wm. E., Clark Univ., Worcester, Mass. (29). 1881. **A**

Stowell, Prof. T. B., Potsdam, N. Y. (28). 1885. **F**

Stuart, Prof. A. P. S., Lincoln, Nebraska (21). 1874. **C**

Sturgis, Wm. C., 384 Whitney Ave., New Haven, Conn. (40). 1892. **G**

Sturtevant, E. Lewis, M.D., So. Framingham, Mass. (29). 1882. **G**

Swift, Lewis, Ph.D., Warner Observatory, Rochester, N. Y. (29). 1882. **A**

Swingle, W. T., Eustis, Florida (40). 1892. **G**

Tainter, Charles Sumner, Central Power Station, Washington, D. C. (29). 1881. **B D A**

Taylor, Thos., M.D., Department of Agriculture, Washington, D. C. (29). 1885. **F C**

Terry, Prof. N. M., U. S. Naval Acad., Annapolis, Md. (23). 1874. **B**

Tesla, Nikola, LL.D., 55 W. 27th St., New York, N. Y. (43). 1895. **B**

Thomas, Benj. F., Ph.D., State Univ., Columbus, Ohio (29). 1882. **B A**

Thomas, Prof. M. B., Crawfordsville, Ind. (41). 1894. **G**

Thompson, Joseph Osgood, Haverford College, Pa. (41). 1893.

Thomson, Elihu, Thomson-Houston Electric Co., Lynn, Mass. (37). 1888. **B**

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Thruston, Gates Phillips, Nashville, Tenn. (38). 1890. **H**

Thurston, Prof. R. H., Sibley College, Cornell University, Ithaca, N. Y. (23). 1875. D
Thwing, Charles B., Northwestern Univ., Evanston, Ill. (38). 1892. B
Tittmann, Otto H., U. S. Coast and Geodetic Survey Office, Washington, D. C. (24). 1888. A
Todd, Prof. David P., Director Lawrence Observ., Amherst College, Amherst, Mass. (27). 1881. A B D
Todd, Prof. James E., Box 22, Vermillion, So. Dak. (22). 1886. E F
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Tracy, Sam'l M., Agricultural College, Miss. (27). 1881. G
Traphagen, Frank W., Ph.D., Bozeman, Montana (35). 1889. C F E
Trelease, Dr. Wm., Director Missouri Botanical Gardens, St. Louis, Mo. (39). 1891. G
Trimble, Prof. Henry, 145 No. 10th St., Philadelphia ,Pa. (34). 1889. C
Trumbull, Dr. J. Hammond, Hartford, Conn. (29). 1882. H
Tucker, Willis G., M.D., Albany Med. Coll , Albany, N. Y. (29). 1888. C
TUCKERMAN, ALFRED, Ph.D., 342 W. 57th St., New York, N. Y. (39). 1891. C
Tuttle, Prof. Albert H., Univ. of Virginia, Charlottesville, Va. (17). 1874. F
Twitchell, E., 10 Bellevue Ave., Mt. Auburn, Cincinnati, Ohio (39). 1891. C

Uhler, Philip R., 254 W. Hoffman St., Baltimore, Md. (19). 1874. F E
Uline, Edwin Burton, Lake Forest, Ill. (42). 1894. G
Underwood, Prof. Lucien M., De Pauw Univ., Greencastle, Ind. (33). 1885. G
Updegraff, Milton, Observatory, Columbia, Mo. (40). 1895. A
Upham, Warren, Librarian of the Minnesota Historical Society, St. Paul, Minn. (25). 1880. E
Upton, Winslow, Brown Univ., Providence, R. I. (29). 1883. A

Van Dyck, Prof. Francis Cuyler, New Brunswick, N. J. (28). 1882. B C F
Van Hise, Charles R., Univ. of Wisconsin, Madison, Wis. (37). 1890.
Van Vleck, Prof. John M., Wesleyan Univ., Middletown, Conn. (23). 1875. A
Veeder, Major Albert, M.D., Lyons, Wayne Co., N. Y. (36). 1895.
Venable, Prof. F. P., Chapel Hill, N. C. (39). 1891. C
Vining, Edward P., care Chas. B. Griggs, Washington St., Brookline, Mass. (32). 1887. H
Vogdes, A. W., Capt. 5th Art'y, Alcatraz Island, San Francisco, Cal. (32). 1885. E F
Voorhees, Louis A., Agric. Exper. Station, New Brunswick, N. J. (43). 1895. C

Wadsworth, Prof. M. Edward, Ph.D., Director of the Michigan Mining School, State Geologist of Michigan, Houghton, Mich. (23). 1874. E
Waite, M. B., Dep't of Agric., Washington, D. C. (37). 1893. G

Walcott, Charles D., Director U. S. Geological Survey, Washington, D. C. (25). 1882. **E F**

Waldo, Prof. Clarence A., Purdue Univ., Lafayette, Ind. (37). 1889. **A**

Waldo, Leonard, S. D., Bridgeport, Conn. (28). 1880. **A**

Wallace, Wm., Ansonia, Conn. (28). 1882.

WALLER, E., School of Mines, Columbia College, New York, N. Y. (23). 1874.

Walmsley, W. H., 69 Washington St., Chicago, Ill. (28). 1883. **F**

Wanner, Atreus, York, York Co., Pa. (36). 1890. **H**

Ward, Prof. Henry A., Rochester, N. Y. (13). 1875. **F E H**

Ward, Lester F., U. S. Geological Survey, Washington, D. C. (26). 1879. **E G**

Ward, Dr. R. H., 53 Fourth St., Troy, N. Y. (17). 1874. **G F**

Ward, Wm. E., Port Chester, N. Y. (36). 1889. **D**

Warder, Prof. Robert B., Howard Univ., Washington, D. C. (19). 1881. **C B**

Warner, Prof. A. G., Leland Stanford jr. Univ., Palo Alto, Cal. (38). 1892. **I**

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Warner, Worcester R., 887 Case Ave., Cleveland, Ohio (33). 1888. **A B D**

Warren, Dr. Joseph W., Bryn Mawr Coll., Bryn Mawr, Pa. (31). 1886. **F**

Warren, Prof. S. Edward, Newton, Mass. (17). 1875. **A-I**

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Weber, Prof. Henry A., Ohio State Univ., Columbus, Ohio (35). 1888. **F**

Webster, F. M., Wooster, Ohio (35). 1890. **F**

Webster, Prof. N. B., Vineland, N. J. (7). 1874. **B C E**

Weed, Clarence M., Durham, N. H. (38). 1890. **F**

WEST, Dr. CHARLES E., Brooklyn, N. Y. (1). 1895.

Wheeler, Prof. C. Gilbert, 143 Lake St., Chicago, Ill. (18). 1883. **C E**

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White, David, U. S. National Museum, Washington, D. C. (40). 1892. **E F**

White, Prof. H. C., Univ. of Georgia, Athens, Ga. (29). 1885. **C**

WHITE, PROF. I. C., Univ. of W. Va., Morgantown, W. Va. (25). 1882. **E**

Whiteaves, J. F., Geol. Survey, Ottawa, Ontario, Can. (31). 1887. **E F**

Whitfield, R. P., American Museum Natural History, 77th St. and 8th Avenue, New York, N. Y. (18). 1874. **E F H**

Whiting, Miss Sarah F., Wellesley College, Wellesley, Mass. (31). 1883. **B A**

Whitman, Prof. Frank P., Adelbert College, Cleveland, Ohio (33). 1885. **A B**

Wilbur, A. B., Middletown, N. Y. (23). 1874. **E**

Wiley, Prof. Harvey W., Dep't of Agric., Washington, D.C. (21). 1874. **C**

Williams, Benezette, 171 La Salle St., Chicago, Ill. (33). 1887. **D**

Williams, Charles H., M.D., C. B. and Q. Gen. Office, Adams St., Chicago, Ill. (22). 1874.

Williams, Prof. Edw. H., jr., 117 Church St., Bethlehem, Pa. (25). 1894. **E D**

Williams, Prof. Henry Shaler, Yale College, New Haven, Conn. (18). 1882. **E F**

Williams, Prof. Thos. A., Agricultural Coll., Brookings, So. Dak. (42). 1894. **G**

Willson, Prof. Frederick N., Princeton, N. J. (33). 1887. **A D**

Willson, Robert W., Cambridge, Mass. (30). 1890. **B A**

Wilson, Joseph M., Room 1036, Drexel Building, Philadelphia, Pa. (33), 1886. **D**

Wilson, Robert N., Macleod, Alberta, Can. (42). 1895. **H**

Wilson, Thomas, U. S. Nat'l Museum, Washington, D. C. (36). 1888. **H**

Wilson, Prof. William Powell, Dept. of Biology, Univ. of Pa., Philadelphia, Pa. (38). 1889. **G**

Winchell, Horace V., 1306 S. E. 7th St., Minneapolis, Minn. (34). 1890. **E C**

Winchell, Prof. N. H., Univ. of Minnesota, Minneapolis, Minn. (19). 1874. **E H**

Wing, Henry H., 3 Reservoir Ave., Ithaca, N. Y. (38). 1890.

Winlock, Wm. C., Smithsonian Institution, Washington, D. C. (33). 1885. **A B**

Winslow, Arthur, Geologist and Mining Expert, Rooms 411 and 412, Roe Building, 5th and Pine Sts., St. Louis, Mo. (37). 1889. **E**

Winterhalter, A. G., Lt. U. S. N., care Navy Dept., Washington, D. C. (37). 1893. **A**

Withers, Prof. W. A., Agric. and Mechanical College, Raleigh, N. C. (33). 1891. **C**

Witthaus, Dr. R. A., 303 W. 77th St., New York, N. Y. (35). 1890.

Wolff, Dr. J. E., 15 Story St., Cambridge, Mass. (36). 1894. **E**

Wood, Prof. De Volson, Hoboken, N. J. (29). 1881.

Woodbury, C. J. H., Amer. Bell Telephone Co., 125 Milk St., Boston, Mass. (29). 1884. **D**

Woodward, Prof. Calvin M., 1761 Missouri Ave., St. Louis, Mo. (32). 1884. **D A I**

Woodward, R. S., Columbia College, New York, N. Y. (33). 1885. **A B D**

Wormley, T. G., Univ. of Pennsylvania, Philadelphia, Pa. (20). 1878.

Worthen, W. E., 63 Bleeker St., New York, N. Y. (36). 1888. **D**

Wrampelmeier, Theo. J., Room 17, Appraiser's Building, San Francisco, Cal. (34). 1887. **C**

Wright, Prof. Albert A., Oberlin College, Oberlin, Ohio (24). 1880. **E F**

Wright, Prof. Arthur W., Yale Coll., New Haven. Conn. (14). 1874. **A B**

Wright, Carroll D., LL.D., Dep't of Labor, Washington, D. C. (41). 1894. **I**

Wright, Rev. Geo. F., Oberlin College, Oberlin, Ohio (29). 1882. **E**
Wright, Prof. Thos. W., Union College, Schenectady, N. Y. (36). 1889.
Würtele, Rev. Louis C., Acton Vale, P. Q., Can. (11). 1875. **E**

Youmans, Wm. Jay, M.D., Popular Science Monthly, 1–5 Bond St., New York, N. Y. (28). 1889. **F C**
Young, A. V. E., Northwestern Univ., Evanston, Ill. (33). 1886. **C B**
Young, C. A., Prof. of Astronomy, College of New Jersey, Princeton, N. J. (18). 1874. **A B D**

Zalinski, E. L., U. S. A., care U. S. Legation, Tokio, Japan (36). 1891. **D**
Ziwet, Alexander, 44 Madison St., Ann Arbor, Mich. (38). 1890. **A**

[785 FELLOWS.]

SUMMARY.—PATRONS, 2; CORRESPONDING MEMBERS, 1; MEMBERS, 1115; HONORARY FELLOWS, 3; FELLOWS, 792.
DEC. 31, 1895, TOTAL NUMBER OF MEMBERS OF THE ASSOCIATION, 1913.

DECEASED MEMBERS.

[Unless by special vote of the Council, the names of those only who are members of the Association at the *time of their decease* will be included in this list. Information of the date and place of birth and death, to fill blanks in this list, is requested by the Permanent Secretary.]

Abbe, George Waldo, New York, N. Y. (23). Born in Windham, Conn., Oct. 26, 1811. Died in New York, N. Y., Sept. 25, 1879.

Abert, John James, Washington, D. C. (1). Born in Shepherdstown, Va., Sept. 17, 1788. Died in Washington, D. C., Sept. 27, 1863.

Adams, Charles Baker, Amherst, Mass. (1). Born in Dorchester, Mass., Jan. 11, 1814. Died in St. Thomas, W. I., Jan. 19, 1853.

Adams, Edwin F., Charlestown, Mass. (18).

Adams, Samuel, Jacksonville, Ill. (18). Born Dec. 19, 1806. Died April 29, 1877.

Agassiz, Louis, Cambridge, Mass. (1). Born in Parish of Motier, Switzerland, May 28, 1807. Died in Cambridge, Mass., Dec. 14, 1873.

Ainsworth, J. G., Barre, Mass. (14).

Alexander, Stephen, Princeton, N. J. (1). Born Sept. 1, 1806. Died June 25, 1883.

Allen, Thomas, St. Louis, Mo. (27). Died April 8, 1882.

Allen, Zachariah, Providence, R. I. (1). Born in Providence, R. I., Sept. 15, 1795. Died March 17, 1882.

Allston, Robert Francis Withers, Georgetown, S. C. (3). Born in All Saints Parish, S. C., April 21, 1801. Died near Georgetown, S. C., April 7, 1864.

Alvord, Benjamin, Washington, D. C. (17). Born in Rutland, Vt., Aug. 18, 1813. Died Oct. 16, 1884.

Ames, Nathan P., Springfield, Mass. (1). Born in 1803. Died Apr. 23, 1847.

Andrews, Ebenezer Baldwin, Lancaster, Ohio (7). Born in Danbury, Conn., April 29, 1821. Died in Lancaster, Ohio, Aug. 14, 1880.

Anthony, Charles Hartshorn, Albany, N. Y. (6). Born in Troy, N. Y., June 4, 1812. Died in Albany, N. Y., May 21, 1874.

Antisell, Thomas, Washington, D. C. (33). Born in Dublin, Ireland, Jan. 16, 1817. Died in Washington, D. C., June 14, 1893.

Appleton, Nathan, Boston, Mass. (1). Born in New Ipswich, N. H., Oct. 6, 1779. Died July 14, 1861.

Armsby, James H., Albany, N. Y. (6). Born in Sutton, Mass., Dec. 31, 1810. Died in Albany, N. Y., Dec. 3, 1875.

Armstrong, John W., Fredonia, N. Y. (24).

Ashburner, Charles A., Pittsburgh, Pa. (31). Died Dec. 24, 1889.

Ashburner, Wm., San Francisco, Cal. (29). Born in Stockbridge, Mass., March, 1831. Died in San Francisco, Cal., April 20, 1887.

Atwater, Mrs. S. T., Chicago, Ill. (17). Born Aug. 8, 1812. Died April 11, 1878.

Aufrecht, Louis, Cincinnati, Ohio (30).

Baba, Tatui, New York, N. Y. (36).

Babbitt, Miss Franc E., Coldwater, Mich. (32). Died near Coldwater, Mich., July 6, 1891, aged 67.

Bache, Alexander Dallas, Washington, D. C. (1). Born in Philadelphia, Pa., July 19, 1806. Died at Newport, R. I., Feb. 17, 1867.

Bache, Franklin, Philadelphia, Pa. (1). Born in Philadelphia, Pa., Oct. 25, 1792. Died March 19, 1864.

Bailey, Jacob Whitman, West Point, N. Y. (1). Born in Auburn, Mass., April 29, 1811. Died in West Point, N. Y., Feb. 26, 1857.

Baird, Spencer Fullerton, Washington, D. C. (1). Born in Reading, Pa., Feb. 3, 1823. Died in Wood's Holl, Mass., Aug. 19, 1887.

Baldwin, Charles Candee, Cleveland, Ohio (37). Born in Middletown, Conn., Dec. 2, 1834. Died in Cleveland, Ohio, Feb. 2, 1895.

Bardwell, F. W., Lawrence, Kan. (13). Died in 1878.

Barnard, F. A. P., New York, N. Y. (7). Born in Sheffield, Mass., May 5, 1809. Died in New York, April 27, 1889.

Barnard, John Gross, New York, N. Y. (14). Born in Sheffield, Mass., May 19, 1815. Died in Detroit, Mich., May 14, 1882.

Barrett, Dwight H., Baltimore, Md. (36). Died in March, 1889.

Barrett, Moses, Milwaukee, Wis. (21). Died in 1873.

Barry, Redmond, Melbourne, Australia (25). Born in Ballyclough, Co. Cork, Ireland, in 1813. Died in Melbourne. Nov. 23, 1880.

Bassett, Daniel A., Los Angeles, Cal. (29). Born Dec. 8, 1819. Died May 26, 1887.

Bassnett, Thomas, Jacksonville, Fla. (8). Born 1807. Died in Jacksonville, Fla., Feb. 16, 1886.

Batchelder, John Montgomery, Cambridge, Mass. (8). Born in New Ipswich, N. H., Oct. 13, 1811. Died in Cambridge, July 3, 1892.

Bayne, Herbert Andrew, Kingston, Ont., Can. (29). Born in Londonderry, Nova Scotia, Aug. 16, 1846. Died in Pictou, Can., Sept. 16, 1886.

Beach, J. Watson, Hartford, Conn. (23). Born Dec. 28, 1823. Died Mar. 16, 1887.

Beauregard, Gustave T., New Orleans, La. (30). Died Feb. 20, 1893, aged 75.

Beck, C. F., Philadelphia, Pa. (1).

Beck, Lewis Caleb, New Brunswick, N. J. (1). Born in Schenectady, N. Y., Oct. 4, 1798. Died April 20, 1853.

Beck, Theodoric Romeyn, Albany, N. Y. (1). Born in Schenectady, N. Y., Aug. 11, 1791. Died in Utica, N. Y., Nov. 19, 1855.

Beckwith, Henry C., Coleman's Station, N. Y. (29). Died July 12, 1885.

Belfrage, G. W., Clifton, Texas (29). Died Dec. 7, 1882.

Belknap, William B., Louisville, Ky. (29).

Bell, Samuel N., Manchester, N. H. (7). Born in Chester, N. H., March 25, 1829. Died in Manchester, N. H., Feb. 8, 1889.

Belt, Thomas, London, Eng. (27). Died Sept. 8, 1878.

Beman, Nathan Sidney Smith, Troy, N. Y. (6). Born in Canaan, N. Y., Nov. 26, 1785. Died in Carbondale, Ill., Aug. 6, 1871.

Benedict, George Wyllys, Burlington, Vt. (16). Born Jan. 11, 1796. Died Sept. 28, 1871.

Benjamin, Edmund Burke, New York, N. Y. (19). Born in East Bloomfield, N. Y., July 16, 1828. Died in New York, May 29, 1894.

Bicknell, Edwin, Boston, Mass. (18). Born in 1830. Died March 19, 1877.

Binney, Amos, Boston, Mass. (1). Born in Boston, Mass., Oct. 18, 1803. Died in Rome, Feb. 18, 1847.

Binney, John, Boston, Mass. (3).

Blackie, Geo. S., Nashville, Tenn. (26).

Blair, Henry W., Washington, D. C. (26). Died Dec. 15, 1884.

Blake, Eli Whitney, New Haven, Conn. (1). Born Jan. 27, 1795. Died Aug. 18, 1886.

Blake, Eli Whitney, Providence, R. I. (15). Born in New Haven, Conn. Died Oct. 1, 1895, aged 59 years.

Blake, Francis C., Mansfield Valley, Pa. (29). Died Feb. 21, 1891.

Blake, Homer Crane, New York, N. Y. (28). Born in Cleveland, Ohio, Feb. 1, 1822. Died in New York, N. Y., Jan. 20, 1880.

Blanding, William, ———, R. I. (1).

Blatchford, Thomas Wyndeatt, Troy, N. Y. (6). Born in Topham, Eng., in 1794. Died in Troy, N. Y., Jan. 7, 1866.

Blatchley, Miss S. L., New Haven, Conn. (19). Died March 13, 1873.

Boadle, John, Haddonfield, N. J. (20). Born in 1805. Died in July, 1878.

Bomford, George, Washington, D. C. (1). Born in New York, N. Y., 1780. Died in Boston, Mass., March 25, 1848.

Bowditch, Henry Ingersoll, Boston, Mass. (2). Born in Salem, Mass., Aug. 9, 1808. Died in Boston, Mass., Jan. 14, 1892.

Bowles, Miss Margaretta, Columbia, Tenn. (26). Died July, 1887.

Bowron, James, South Pittsburg, Tenn. (26). Died in Dec., 1877.

Bradley, Leverette, Jersey City, N. J. (15). Died in 1875.

Braithwaite, Jos., Chambly, C. W. (11).

Breckinridge, S. M., St. Louis, Mo. (27). Died May 28, 1891.

Briggs, Albert D., Springfield, Mass. (13). Died Feb. 20, 1881.

Briggs, Robert, Philadelphia, Pa. (29). Born May 18, 1822. Died July 24, 1882.

Brigham, Charles Henry, Ann Arbor, Mich. (17). Born in Boston, Mass., July 27, 1820. Died Feb. 19, 1879.

Brinsmade, Thomas C., Troy, N. Y. (6). Born in New Hartford, Conn., June 16, 1802. Died in Troy, N. Y., June 22, 1868.

Bronson, Henry, New Haven, Conn. (41). Born in Waterbury, Conn., Jan. 30, 1804. Died in New Haven, Nov. 26, 1893.

Broomall, John M., Media, Pa. (23). Died June, 1894.

Bross, William, Chicago, Ill. (7). Died in 1890.

Brown, Andrew, Natchez, Miss. (1).

Brown, Horace, Salem, Mass. (27). Died in July, 1883.

Buel, David, Jr., Troy, N. Y. (6). Born in Litchfield, Conn., Oct. 22, 1784. Died in Troy, N. Y. in 1860.

Bull, John, Washington, D. C. (31). Born Aug. 1, 1819. Died June 9, 1884.
Bulloch, Walter H., Chicago, Ill. (30).
Burbank, L. S., Woburn, Mass. (18).
Burgess, Edward, Boston, Mass. (22). Born in Barnstable, Mass., June 30, 1848. Died in Boston, July 12, 1891.
Burke, Joseph Chester, Middletown, Conn. (29). Died in 1885.
Burnap, George Washington, Baltimore, Md. (12). Born in Merrimack, N. H., Nov. 30, 1802. Died in Philadelphia, Pa., Sept. 8, 1859.
Burnett, Waldo Irving, Boston, Mass. (1). Born in Southborough, Mass., July 12, 1828. Died in Boston, Mass., July 1, 1854.
Butler, Thomas Belden, Norwalk, Conn. (10). Born Aug. 22, 1806. Died June 8, 1873.

Cairns, Frederick A., New York, N. Y. (27). Died in 1879.
Campbell, Mrs. Mary H., Crawfordsville, Ind. (22). Died Feb. 27, 1882
Carpenter, Thornton, Camden, S. C. (7).
Carpenter, William M., New Orleans, La. (1).
Carpmael, Charles, Toronto, Can. (31). Died Oct. 20, 1894.
Case, Leonard, Cleveland, Ohio (15). Born June 27, 1820. Died Jan. 5, 1880.
Case, William, Cleveland, Ohio (6).
Caswell, Alexis, Providence, R. I. (2). Born Jan. 29, 1799. Died in Providence, R. I., Jan. 8, 1877.
Chadbourne, Paul Ansel, Amherst, Mass. (10). Born in North Berwick, Me., Oct. 21, 1823. Died Feb. 23, 1883.
Chapin, J. H., Meriden, Conn. (33). Died in 1892.
Chapman, Nathaniel, Philadelphia, Pa. (1). Born in Alexandria Co., Va., May 28, 1780. Died July 1, 1853.
Chase, Pliny Earle, Haverford College, Pa. (18). Born in Worcester, Mass., Aug. 18, 1820.
Chase, Stephen, Hanover, N. H. (2). Born in 1818. Died Aug. 5, 1851.
Chauvenet, William, St. Louis, Mo. (1). Born May 24, 1819. Died Dec. 13, 1870.
Cheesman, Louis Montgomery, Hartford, Conn. (32). Born in 1858. Died in Jan., 1885.
Cheney, Miss Margaret S., Jamaica Plain, Mass. (29). Died in 1882.
Chevreul, Michel Eugène, Paris, France (35). Born in Angiers, France, Aug. 31, 1786. Died April 9, 1889.
Clapp, Asahel, New Albany, Ind. (1). Born Oct. 5, 1792. Died Dec. 15, 1862.
Clark, Henry James, Cambridge, Mass. (18). Born in Easton, Mass., June 22, 1826. Died in Amherst, Mass., July 1, 1873.
Clark, Joseph, Cincinnati, Ohio (5).
Clark, Patrick, Rahway, N. J. (33). Died March 5, 1887.
Clarke, A. B., Holyoke, Mass. (13).
Clarke, Charles S., Peoria, Ill. (34). Died Nov. 15, 1890.
Cleaveland, C. H., Cincinnati, Ohio (9).
Cleveland, A. B., Cambridge, Mass. (2).
Coakley, George W., Hempstead, L. I. (29). Born in 1814. Died Aug. 5, 1893.

Coffin, James Henry, Easton, Pa. (1). Born in Northampton, Mass., Sept. 6, 1806. Died Feb. 6, 1873.

Coffin, John H. C., Washington, D. C. (1). Born in Wiscasset, Maine, Sept. 14, 1815. Died in Washington, D. C., Jan. 8, 1890.

Coffinberry, Wright Lewis, Grand Rapids, Mich. (20). Born in Lancaster, Ohio, April 5, 1807. Died in Grand Rapids, Mich., March 26, 1889.

Colburn, E. M., Peoria, Ill. (33). Born in Rome, N. Y., Sept. 13, 1813. Died in Peoria, Ill., May 29, 1890.

Cole, Frederick, Montreal, Can. (31). Died in 1887.

Cole, Thomas, Salem, Mass. (1). Born Dec. 24, 1779. Died June 24, 1852.

Coleman, Henry, Boston, Mass. (1).

Collins, Frederick, Washington, D. C. (28). Born Dec. 5, 1842. Died Oct. 27, 1881.

Colman, Henry, Lynn, Mass. (25). Died Nov., 1893.

Conrad, Timothy Abbott, Philadelphia, Pa. (1). Born in New Jersey, June 21, 1803. Died Aug. 9, 1877.

Cook, George H., New Brunswick, N. J. (4). Born in Hanover, N. J., Jan. 5, 1818. Died in New Brunswick, N. J., Sept. 22, 1889.

Cooke, Caleb, Salem, Mass. (18). Born Feb. 15, 1838. Died June 5, 1880.

Cooper, William, Hoboken, N. J. (9). Died in 1864.

Cope, Mary S., Germantown, Pa. (33). Born in Germantown, Pa., July 13, 1853. Died in Germantown, Jan. 4, 1888.

Copes, Joseph S., New Orleans, La. (11). Born Dec. 9, 1811. Died March 1, 1885.

Corning, Erastus, Albany, N. Y. (6). Born in Norwich, Conn., Dec. 14, 1794. Died April 9, 1872.

Costin, M. P., Fordham, N. Y. (30). Died June 8, 1884.

Couper, James Hamilton, Darien, Ga. (1). Born March 5, 1794. Died July 3, 1866.

Coxe, Eckley B., Drifton, Pa. (23). Died May 13, 1895.

Coyrière-Pardo, E. Miriam, New York, N. Y. (36). Born in London, Eng., Sept. 2, 1845. Died in New York, N. Y., Feb. 6, 1893.

Cramp, John Mockett, Wolfville, N. S. (11). Born in Kent, England, July 25, 1796. Died Dec. 6, 1881.

Crehore, John D., Cleveland, Ohio (24).

Cresson, Hilborne T., Philadelphia, Pa. (39). Died in New York, N. Y., Sept. 6, 1894.

Crocker, Charles F., Lawrence, Mass. (22). Died in July, 1881.

Crocker, Miss Lucretia, Boston, Mass. (29). Died in 1886.

Crosby, Alpheus, Salem, Mass. (10). Born in Sandwich, N. H., Oct. 13, 1810. Died April 17, 1874.

Crosby, Thomas Russell, Hanover, N. H. (18). Born Oct. 22, 1816. Died March 1, 1872.

Crosier, Edward S., New Albany, Ind. (29). Died in June, 1891.

Croswell, Edwin, Albany, N. Y. (6). Born in Catskill, N. Y., May 29, 1797. Died June 13, 1871.

Crow, Wayman, St. Louis, Mo. (27). Born March 7, 1808. Died May 10, 1885.

Cummings, Joseph, Evanston, Ill. (13). Born in Falmouth, Me., March 3, 1817. Died in Evanston, Ill., May 7, 1890.

Curry, W. F., Geneva, N. Y. (11).

Curtis, George William, Staten Island, N. Y. (36). Born in Providence, R. I., Feb. 24, 1824. Died Aug. 31, 1892.

Curtis, Josiah, Washington, D. C. (18). Died Aug. 1, 1883.

Cutting, Hiram Adolphus, Lunenburgh, Vt. (17). Born in Concord, Vt., Dec. 23, 1832. Died in Lunenburgh, April 18, 1892.

Da Costa, Chas. M., New York, N. Y. (36). Died in 1890.

Dalrymple, Edwin Augustine, Baltimore, Md. (11). Born in Baltimore, Md., June 4, 1817. Died Oct. 30, 1881.

Dana, James Dwight, New Haven, Conn. (1). Born in Utica, N. Y., Feb. 12, 1813. Died in New Haven, Conn, April 14, 1895.

Dana, S. S., Lowell, Mass. (1)

Danforth, Edward, Elmira, N. Y. (11). Died in Elmira, N. Y., June 13, 1888.

Davenport, H. W., Washington, D. C. (30).

Davis, I. Thomas, Washington, D. C. (40). Died Jan. 19, 1892.

Day, Austin G., New York, N. Y. (29). Died Dec. 28, 1889.

Dayton, Edwin A., Madrid, N. Y. (7). Born in 1827. Died June 24, 1873.

Dean, Amos, Albany, N. Y. (6). Born in Barnard, Vt., Jan. 16, 1803. Died Jan. 26, 1868.

Dearborn, George H. A. S., Roxbury, Mass. (1).

Dekay, James Ellsworth, New York, N. Y. (1). Born in New York, 1792. Died Nov. 21, 1851.

Delano, Joseph C., New Bedford, Mass. (5). Born Jan. 9, 1796. Died Oct. 16, 1886.

De Laski, John, Carver's Harbor, Me. (18).

Devereux, John Henry, Cleveland, Ohio (18). Born in Boston, Mass., April 5, 1832. Died in Cleveland, Ohio, March 17, 1886.

Dewey, Chester, Rochester, N. Y. (1). Born in Sheffield, Mass., Oct. 25, 1781. Died Dec. 15, 1867.

Dexter, G. M., Boston, Mass. (11).

Dickerson, Edward N., New York, N. Y. (36).

Dillingham, W. A. P., Augusta, Me. (17).

Dimmick, L. N., Santa Barbara, Cal. (29). Died May 31, 1884.

Dinwiddie, Hardaway H., College Station, Texas (32). Died Dec. 11, 1887.

Dinwiddie, Robert, New York, N. Y. (1). Born in Dumfries, Scotland, July 23, 1811. Died in New York, N. Y., July 12, 1888.

Dixwell, Geo. B., Boston, Mass. (29). Died April, 1885.

Doggett, George Newell, Chicago, Ill. (33). Born in Chicago, Ill., Dec. 19, 1858. Died in Fredericksburg, Va., Jan. 15, 1887.

Doggett, Mrs. Kate Newell, Chicago, Ill. (17). Born in Castleton, Vt., Nov. 5, 1828. Died in Havana, Cuba, March 13, 1884.

Doggett, Wm. E., Chicago, Ill. (17). Born Nov. 20, 1820. Died in 1876.

Doolittle, L., Lenoxville, C. E. (11). Died in 1862.

Dorand, Fred James, Chester, Vt. (38). Born in Rockingham, Vt., Dec. 6, 1856. Died in Aiken, S. C., April 17, 1893.

Dorr, Ebenezer Pearson, Buffalo, N. Y. (25). Born in Hartford, Vt. Died in Buffalo, N. Y., April 29, 1882.

Dorsey, J. Owen, Takoma Park, D. C. (31). Died in Feb., 1895.

Dow, John Melmoth, New York, N. Y. (31). Died in New York, Nov. 4, 1892.

Dowling, John W., New York, N. Y. (36). Born in New York, Aug. 15, 1837. Died in Goshen, N. Y., Jan. 15, 1892.

Draper, Henry, New York, N. Y. (28). Born in New York, N. Y., March 7, 1837. Died Nov. 20, 1882.

Drowne, Charles, Canaan Four Corners, N. Y. (6). Born July 5, 1824. Died in 1888.

Ducatel, Julius Timoleon, Baltimore, Md. (1). Born in Baltimore, Md., June 6, 1798. Died April 25, 1849.

Duffield, George, Detroit, Mich. (10). Born in Strasburg, Pa., July 4, 1794. Died in Detroit, Mich., June 26, 1869.

Dumont, A. H., Newport, R. I. (14).

Dun, Walter Angus, Cincinnati, Ohio (31). Born in London, Ohio, March 1, 1857. Died in Cincinnati, Nov. 7, 1887.

Duncan, Lucius C., New Orleans, La. (10). Born in 1801. Died Aug. 9, 1855.

Dunn, Robinson P., Providence, R. I. (14). Born in Newport, R. I., May 31, 1825. Died in Newport, Aug. 28, 1867.

Dury, Henry M., Nashville, Tenn. (38). Died April 15, 1891.

Eads, James Buchanan, New York, N. Y. (27). Born May 23, 1820. Died March 8, 1887.

Easton, Norman, Fall River, Mass. (14). Died Dec. 21, 1872.

Eaton, D. G., Brooklyn, N. Y. (19). Born in Portland, Me., March 6, 1822. Died in Brooklyn, N. Y., March 18, 1895.

Eaton, James H., Beloit, Wis. (17). Died Jan. 5, 1877.

Elliott, Ezekiel Brown, Washington, D. C. (10). Born July 16, 1823. Died May 24, 1888.

Elsberg, Louis, New York, N. Y. (23). Born in Iserlohn, Prussia, April 2, 1836. Died in New York, N. Y., Feb. 19, 1885.

Elwyn, Alfred Langdon, Philadelphia, Pa. (1). Born in Portsmouth, N. H., July 9, 1804. Died in Philadelphia, Pa., March 15, 1884.

Ely, Charles Arthur, Elyria, Ohio (4).

Emerson, Geo. Barrell, Boston, Mass. (1). Born in Kennebunk, Me., Sept. 12, 1797. Died March 14, 1881.

Emmons, Ebenezer, Williamstown, Mass. (1). Born in Middlefield, Mass., May 16, 1799. Died Oct. 1, 1863.

Engelmann, George, St. Louis, Mo. (1). Born in Frankfort-on-the Main, Germany, Feb. 2, 1809. Died Feb. 4, 1884.

Engstrom, A. B., Burlington, N. J. (1).

Eustis, Henry Lawrence, Cambridge, Mass. (2). Born Feb. 1, 1819. Died Jan. 11, 1885.

Evans, Asher B., Lockport, N. Y. (19). Born in Hector, N. Y., Sept. 21, 1834. Died in Lockport, Sept. 24, 1891.

Evans, Edwin, Streator, Ill. (30). Died May 5, 1889.

Everett, Edward, Boston, Mass. (2). Born in Dorchester, Mass., April 11, 1794. Died in Boston, Mass., Jan. 15, 1865.

Ewing, Thomas, Lancaster, Ohio (5). Born in Ohio Co., Va., Dec. 28, 1789. Died Oct. 26, 1871.

Faries, R. J., Wauwatosa, Wis. (21). Died May 31, 1878.

Farmer, Moses G., Eliot, Me. (9). Died in Chicago, Ill., May 25, 1893.

Farnam, J. E., Georgetown, Ky. (26).

Farquharson, Robert James, Des Moines, Iowa (24). Born July 15, 1824. Died Sept. 6, 1884.

Felton, Samuel Morse, Philadelphia, Pa. (29). Born in Newbury, Mass., July 19, 1809. Died in Philadelphia, Pa., Jan. 24, 1889.

Ferrel, William, Kansas City, Mo. (11). Born in Bedford Co., Pa., Jan. 29, 1817. Died near Kansas City, Sept. 18, 1891.

Ferris, Isaac, New York, N. Y. (6). Born in New York, Oct. 9, 1798. Died in Roselle, N. J., June 16, 1873.

Feuchtwanger, Lewis, New York, N. Y. (11). Born in Fürth, Bavaria, Jan. 11, 1805. Died in New York, N. Y., June 25, 1876.

Ficklin, Joseph, Columbia, Mo. (20). Born in Winchester, Ky., Sept. 9, 1833. Died in Columbia, Mo., Sept. 6, 1887.

Fillmore, Millard, Buffalo, N. Y. (7). Born in New York, Jan. 7, 1800. Died March 8, 1874.

Fisher, Mark, Trenton, N. J. (10).

Fitch, Alexander, Hartford, Conn. (1). Born March 25, 1799. Died Jan. 20, 1859.

Fitch, O. H., Ashtabula, Ohio (7). Born in 1803. Died Sept. 17, 1882.

Floyd, Richard S., San Francisco, Cal. (34). Died Oct. 17, 1890.

Foote, A. E., Philadelphia, Pa. (21). Born in Hamilton, N. Y., Feb. 6, 1846. Died in Atlanta, Ga., Oct. 10, 1895.

Foote, Herbert Carrington, Cleveland, Ohio (35). Born in 1852. Died in Cleveland, Aug. 24, 1888.

Forbush, E. B., Buffalo, N. Y. (15).

Force, Peter, Washington, D. C. (4). Born in New Jersey, Nov. 26, 1790. Died in Washington, D. C., Jan. 23, 1868.

Ford, A. C., Nashville, Tenn. (26).

Forshey, Caleb Goldsmith, New Orleans, La. (21). Born in Somerset Co., Pa., July 18, 1812. Died in Carrollton, La., July 25, 1881.

Foster, John Wells, Chicago, Ill. (1). Born in Brimfield, Mass., March 4, 1815. Died in Chicago, Ill., June 29, 1873.

Foucon, Felix, Madison, Wis. (18).

Fowle, Wm. Bentley, Boston, Mass. (1). Born in Boston, Mass., Oct. 17, 1795. Died Feb. 6, 1865.

Fox, Charles, Grosse Ile, Mich. (7).

Fox, Joseph G., Easton, Pa. (31). Born in Adams, N. Y., Sept. 7, 1833. Died in Easton, Pa., Dec. 27, 1889.

Frazer, John Fries, Phila., Pa. (1.) Born July 8, 1812. Died Oct. 12, 1872.

Freeman, Spencer Hedden, Cleveland, Ohio (29). Born Oct. 3, 1855. Died Feb. 2, 1886.

French, John William, West Point, N. Y. (11). Born in Connecticut, about 1810. Died in West Point, N. Y., July 8, 1871.

Fristoe, E. T., Washington, D. C. (40).

Frothingham, Frederick, Milton, Mass. (11). Born in Montreal, P. Q., April 9, 1825. Died in Milton, March 19, 1891.

Fuller, H. Weld, Boston, Mass. (29). Died Aug. 14, 1889.

Garber, A. P., Columbia, Pa. (29). Died Aug. 26, 1881.

Gardiner, Frederic, Middletown, Conn. (23). Born in Gardiner, Me., Oct. 22, 1822. Died in Middletown, Conn., July 17, 1889.

Garrison, H. D., Chicago, Ill. (31). Died in Feb., 1891.

Gavit, John E., New York, N. Y. (1). Born in New York, Oct. 29, 1819. Died in Stockbridge, Mass., Aug. 25, 1874.

Gay, Martin, Boston, Mass. (1). Born in 1804. Died Jan. 12, 1850.

Genth, Friedrich Augustus, Philadelphia, Pa. (24). Born in Waechtersbach, Hesse Cassel, May 17, 1820. Died in Philadelphia, Pa., Feb. 2, 1892.

Gibbon, J. H., Charlotte, N. C. (3).

Gilbreth, Mary E., Brookline, Mass. (42). Born May 9, 1864. Died Aug. 8, 1894.

Gillespie, William Mitchell, Schenectady, N. Y. (10). Born in New York, N. Y., 1816. Died in New York, Jan. 1, 1868.

Gilmore, Robert, Baltimore, Md. (1).

Glazier, W. W., Key West, Fla. (29). Died Dec. 11, 1880.

Goldmark, J., New York, N. Y. (29). Died in April, 1882.

Gordon, William J., Cleveland, Ohio (29). Died Nov. 23, 1892.

Gould, Augustus Addison, Boston, Mass. (11). Born April 23, 1805. Died Sept. 15, 1866.

Gould, Benjamin Apthorp, Boston, Mass. (2). Born in Lancaster, Mass., June 15, 1787. Died Oct. 24, 1859.

Graham, James D., Washington, D. C. (1). Born in Virginia, 1799. Died in Boston, Mass., Dec. 28, 1865.

Gray, Alonzo, Brooklyn, N. Y. (13). Born in Townsend, Vt., Feb. 21, 1808. Died in Brooklyn, N. Y., March 10, 1860.

Gray, Asa, Cambridge, Mass. (1). Born in Paris, N. Y., Nov. 18, 1810. Died in Cambridge, Mass., Jan. 30, 1888.

Gray, James H., Springfield, Mass. (6).

Green, Everett Wilmer, Madison, N. J. (10). Born Oct. 5, 1834. Died in 1864.

Greene, Benjamin D., Boston, Mass. (1). Died Oct. 14, 1862, aged 68.

Greene, Benjamin Franklin, Troy, N. Y. (2). Born in Lebanon, N. H., Oct. 25, 1817.

Greene, Samuel, Woonsocket, R. I. (9). Died in 1868.

Greene, Thomas A., Milwaukee, Wis. (31). Died in Sept., 1894.

Greer, James, Dayton, Ohio (20). Died in Feb., 1874.

Griffith, Ezra H., Chicago, Ill. (39). Died Aug. 18, 1894.

Griffith, Robert Eglesfield, Philadelphia, Pa. (1). Born in Philadelphia, Pa , Feb. 13, 1798. Died June 26, 1854.

Griswold, John Augustus, Troy, N. Y. (19). Born Nov. 11, 1818. Died Oct. 31, 1872.

Guest, William E., Ogdensburg, N. Y. (6).

Guyot, Arnold, Princeton, N. J. (1). Born Sept. 5, 1809. Died Feb. 8, 1884.

Habel, Louis, Northfield, Vt. (34).

Hackley, Charles William, New York, N. Y. (4). Born in Herkimer Co., N. Y., March 9, 1809. Died in New York, N. Y., January 10, 1861.

Hadley, George, Buffalo, N. Y. (6). Born June, 1813. Died Oct. 16, 1877.

Hagen, Hermann A., Cambridge, Mass. (17). Born in Konigsberg, Prussia, May 30, 1817. Died in Cambridge, Nov. 9, 1893.

Haldeman, Samuel Stehman, Chickies, Pa. (1). Born Aug. 12, 1812. Died Sept. 10, 1880.

Hale, Enoch, Boston, Mass. (1). Born in Westhampton, Mass., Jan. 29, 17[illegible]. Died in Boston, Mass., Nov. 12, 1848.

Hall, Stanton L., Port Chester, N. Y. (36). Born in Pittsfield, Mass., 18[illegible]2.

Hamilton, Jno. M., Coudersport, Pa. (33).

Hampson, Thomas, Washington, D. C. (33).

Hance, Ebenezer, Fallsington P. O., Pa. (7). Died in 1876.

Harding, Myron H., Lawrenceburg, Ind. (30). Died Sept., 1885.

Hare, Robert, Philadelphia, Pa. (1). Born in Philadelphia, Pa., Jan. 17, 1781. Died in Philadelphia, May 15, 1858.

Harger, Oscar, New Haven, Conn. (25). Born in Oxford, Conn., Jan. 12, 1843. Died in New Haven, Conn., Nov. 6, 1887.

Harlan, Joseph G., Haverford, Pa. (8).

Harlan, Richard, Philadelphia, Pa. (1). Born in Philadelphia, Pa., Sept. 19, 1796. Died in New Orleans, La., Sept. 30, 1843.

Harris, Geo. H., Rochester, N. Y. (35). Born in West Greece, N. Y., Dec. 29, 1843. Died in Dansville, N. Y., Oct. 5, 1893.

Harris, Thaddeus William, Cambridge, Mass. (1). Born in Dorchester, Mass., Nov. 12, 1795. Died in Cambridge, Mass., Jan. 16, 1856.

Harrison, A. M., Plymouth, Mass. (29).

Harrison, Benjamin Franklin, Wallingford, Conn. (11). Born April 19, 1811. Died April 23, 1886.

Harrison, Jos., jr., Philadelphia, Pa. (12). Born in Philadelphia, Pa., Sept. 20, 1810. Died in Philadelphia, March 27, 1874.

Hart, Simeon, Farmington, Conn. (1). Born Nov. 17, 1795. Died April 20, 1853.

Hartt, Charles Frederick, Ithaca, N. Y. (18). Born in Nova Scotia, Aug. 20, 1840. Died March 18, 1878.

Hastings, Charles W., Kansas City, Mo. (38). Died in Brooklyn, N. Y., Oct. 24, 1892.

Haven, Joseph, Chicago, Ill. (17). Born in Dennis, Mass., Jan. 4, 1816. Died May 23, 1874.
Hawes, George W., Washington, D. C. (23). Born Dec. 31, 1848. Died June 22, 1882.
Hayden, Ferdinand Vandeveer, Philadelphia, Pa. (29). Born in Westfield, Mass., Sept. 7, 1829. Died Dec. 22, 1887.
Hayden, Horace H., Baltimore, Md. (1). Born in Windsor, Conn., Oct. 13, 1769. Died in Baltimore, Md., Jan. 26, 1844.
Hayes, George E., Buffalo, N. Y. (15).
Hayward, James, Boston, Mass. (1). Born in Concord, Mass., June 12, 1786. Died in Boston, Mass., July 27, 1866.
Hazen, William Babcock, Washington, D. C. (30). Born in Hartford, Vt., Sept. 27, 1830. Died Jan. 16, 1887.
Hedrick, Benjamin Sherwood, Washington, D. C. (19). Born in Davidson Co., N. C., Feb. 13, 1827. Died in Washington, D. C., Sept. 2, 1886.
Heighway, A. E., Cincinnati, Ohio (29). Born Dec. 26, 1820. Died Jan. 24, 1888.
Hempstead, G. S. B., Portsmouth, Ohio (29). Born in 1795. Died July 9, 1883.
Hendricks, J. E., Des Moines, Iowa (29). Died June 8, 1893, aged 79.
Henry, Joseph, Washington, D. C. (1). Born in Albany, N. Y., Dec. 17, 1797. Died May 13, 1878.
Hickox, S. V. R., Chicago, Ill. (17). Died in 1872.
Hicks, William C., New York, N. Y. (34). Died in 1885.
Hilgard, Julius Erasmus, Washington, D. C. (4). Born in Zweibrücken, Bavaria, Jan. 7, 1825. Died in Washington, D. C., May 8, 1891.
Hilgard, Theodore Charles, St. Louis, Mo. (17). Born in Zweibrücken, Bavaria, Feb. 28, 1828. Died March 5, 1875.
Hill, Walter N., Chester, Pa. (29). Born Apr. 15, 1846. Died Mar. 29, 1884.
Hincks, William, Toronto, C. W. (11). Born in 1801. Died July, 1871.
Hitchcock, Edward, Amherst, Mass. (1). Born in Deerfield, Mass., May 24, 1793. Died Feb. 27, 1864.
Hoadley, John Chipman, Boston, Mass. (29). Born Dec. 10, 1818. Died Oct. 21, 1886.
Hobbs, A. C., Bridgeport, Conn. (28). Died in Nov., 1891.
Hockley, Thomas, Philadelphia, Pa. (33). Died March 12, 1892.
Hodgson, William Ballantyne, Savannah, Ga. (10). Born in Edinburgh, Scotland, in 1815.
Hogsett, John J., Danville, Ky. (39). Died Jan. 18, 1891.
Holbrook, John Edwards, Charleston, S. C. (1). Born in Beaufort, S. C., Dec. 30, 1796. Died in Norfolk, Mass., Sept. 8, 1871.
Holman, Mrs. S. W., Boston, Mass. (29). Died May 5, 1885.
Holmes, Edward J., Boston, Mass. (29). Died in July, 1884.
Holmes, Oliver Wendell, Boston, Mass. (29). Born in Cambridge, Mass., Aug. 29, 1809. Died in Boston, Oct. 7, 1894.

Homes, Henry A., Albany, N. Y. (11). Born in Boston, Mass., March 10, 1812. Died in Albany, N. Y., Nov. 3, 1887.

Hopkins, Albert, Williamstown, Mass. (19). Born July 14, 1807. Died May 25, 1872.

Hopkins, James G., Ogdensburg, N. Y. (10). Died in 1860.

Hopkins, T. O., Williamsville, N. Y. (10). Died in 1866.

Hopkins, Wm., Lima, N. Y. (5). Died in March, 1867.

Hoppock, Albert Eugene, Hastings-on-Hudson, N. Y. (29).

Horsford, Eben Norton, Cambridge, Mass. (1). Born in Moscow, N. Y., July 27, 1818. Died in Cambridge, Mass., Jan. 1, 1893.

Horton, C. V. R., Chaumont, N. Y. (10). Died in 1862.

Horton, Samuel Dana, Pomeroy, Ohio (37). Died in Feb., 1895.

Horton, William, Craigville, N. Y. (1).

Hosford, Benj. F., Haverhill, Mass. (13). Died in 1864.

Hough, Franklin Benjamin, Lowville, N. Y. (4). Born in Martinsburgh, N. Y., July 20, 1822. Died June 11, 1885.

Houghton, Douglas, Detroit, Mich. (1). Born in Troy, N. Y., Sept. 21, 1809. Died Oct. 13, 1845.

Hovey, Edmund O., Crawfordsville, Ind. (20). Born July 15, 1801. Died March 10, 1877.

Howland, Edward Perry, Washington, D. C. (29). Born in Ledyard, N. Y., July 20, 1825. Died in Harrisburg, Pa., Sept. 12, 1888.

Howland, Theodore, Buffalo, N. Y. (15).

Hoy, Philo Romayne, Racine, Wis. (17). Born in Richland, Ohio, Nov. 3, 1816. Died in Racine, Wis., Dec. 8, 1892.

Hubbert, James, Richmond, Province of Quebec (16). Died in 1868.

Hunt, Edward Bissell, Washington, D. C. (2). Born in Livingston Co., N. Y., June 15, 1822. Died in Brooklyn, N. Y., Oct. 2, 1863.

Hunt, Freeman, New York, N. Y. (11). Born in Quincy, Mass., March 21, 1804. Died in Brooklyn, N. Y., March 2, 1858.

Hunt, George, Providence, R. I. (9). Born in Sudbury, Mass., Jan. 3, 1811. Died in Providence, R. I., Feb. 21, 1895.

Hunt, Thomas Sterry, New York, N. Y. (1). Born in Norwich, Conn., Sept. 5, 1826. Died in New York, N. Y., Feb. 13, 1892.

Husted, Nathaniel C., Tarrytown-on-Hudson, N. Y. (36). Died Nov. 19, 1891.

Hyatt, Theodore, Chester, Pa. (30).

Ives, Moses B., Providence, R. I. (9). Died in 1857.

Ives, Thomas P., Providence, R. I. (10).

Jackson, Charles Thomas, Boston, Mass. (1). Born in Plymouth, Mass., June 21, 1805. Died Aug. 28, 1880.

Jackson, Josiah, State College, Pa. (35). Died Oct. 10, 1893.

James, Thomas Potts, Cambridge, Mass. (22). Born Sept. 1, 1803. Died Feb. 22, 1882.

Jeffries, John Amory, Boston, Mass. (38). Born in Milton, Mass., Sept. 2, 1859. Died in Boston, Mass., March 26, 1892.

Jenks, John Whipple Potter, Middleborough, Mass. (2). Born in West Boylston, Mass., May 1, 1819. Died in Providence, R. I., Sept. 26, 1894.

Johnson, Hosmer A., Chicago, Ill. (17). Died in Chicago, Feb. 26, 1891.

Johnson, Walter Rogers, Washington, D. C. (1). Born in Leominster, Mass., June 21, 1794. Died April 26, 1852.

Johnson, William Schuyler, Washington, D. C. (31). Born Sept. 20, 1859. Died Oct. 6, 1883.

Jones, Catesby A. R., Washington, D. C. (8).

Jones, Henry A., Portland, Me. (29). Died Sept. 3, 1883.

Jones, James H., Boston, Mass. (28).

Jones, William S., Cleveland, Ohio (37).

Joy, Charles Arad, Stockbridge, Mass. (8). Born in Ludlowville, N. Y., Oct. 8, 1823. Died in Stockbridge, Mass., May 29, 1891.

Judd, Orange, New Haven, Conn. (4). Born near Niagara Falls, N. Y., July 26, 1822. Died in Evanston, Ill., Dec. 27, 1892.

Kedzie, W. K., Oberlin, Ohio (25). Born in Kalamazoo, Mich., July 5, 1851. Died in Lansing, Mich., Apr. 10, 1880.

Keely, George W., Waterville, Me. (1). Died in 1878.

Keep, N. C., Boston, Mass. (13). Died in March, 1875.

Kellogg, James H., Rochester, N. Y. (29). Died Dec. 6, 1891.

Kendall, H. D., Grand Rapids, Mich. (35). Died in Guarymas, Mexico, Jan. 28, 1891.

Kennicott, Robert, West Northfield, Ill. (12). Born Nov. 13, 1835. Died in 1866.

Kerr, Washington Caruthers, Raleigh, N. C. (10). Born May 24, 1827. Died Aug. 9, 1885.

Kidder, Henry Purkitt, Boston, Mass. (29). Born Jan. 8, 1823. Died Jan. 28, 1886.

King, Mary B. Allen, Rochester, N. Y. (15). Born in Woodstock, Vt., Jan. 26, 1799. Died in Rochester, April 3, 1893.

King, Mitchell, Charleston, S. C. (3). Born in Scotland, June 8, 1783. Died Nov. 12, 1862.

Kirkpatrick, James A., Philadelphia, Pa. (7). Died June 3, 1886.

Kirkwood, Daniel, Riverside, Cal. (7). Died in June, 1895.

Kite, Thomas, Cincinnati, Ohio (5). Died Feb. 6, 1884.

Klippart, John H., Columbus, Ohio (17). Died October, 1878.

Knickerbocker, Charles, Chicago, Ill. (17). Died in 1873.

Knight, J. B., Philadelphia, Pa. (21). Died March 10, 1879.

Lacey, O. M., Crawfordsville, Ind. (39). Died Jan. 9, 1891.

Lacklan, R., Cincinnati, Ohio (11).

Lamb, Mrs. Martha J., New York, N. Y. (29). Born in Plainfield, Mass., Aug. 13, 1829. Died in New York, Jan. 2, 1893.

Lamborn, Robert H., New York, N. Y. (28). Born in Pa. in 1836. Died in New York, Jan. 14, 1895.

Lapham, Increase Allen, Milwaukee, Wis. (3). Born in Palmyra, N. Y., March 7, 1811. Died in Oconomowoc, Wis., Sept. 14, 1875.

Larkin, Ethan Pendleton, Alfred Centre, N. Y. (33). Born Sept. 20, 1829. Died Aug. 23, 1887.

LaRoche, Réné, Philadelphia, Pa. (12). Born in Philadelphia, Pa., 1795. Died in Philadelphia, Dec., 1872.

Lasel, Edward, Williamstown, Mass. (1). Born Jan. 21, 1809. Died Jan. 31, 1852.

Lawford, Frederick, Montreal, Canada (11). Died in 1866.

Lawrence, Edward, Charlestown, Mass. (18). Born June, 1810. Died Oct. 17, 1885.

Lea, Isaac, Philadelphia, Pa. (1). Born in Wilmington, Del., March 4, 1792. Died Dec. 8, 1886.

LeConte, John Lawrence, Philadelphia, Pa. (1). Born in New York, May 13, 1825. Died Nov. 15, 1883.

Lederer, Baron von, Washington, D. C. (1).

Lee, William, Washington, D. C. (29). Died March 2, 1893.

Leidy, Joseph, Philadelphia, Pa. (7). Born in Philadelphia, Sept. 9, 1823. Died in Philadelphia, April 30, 1891.

Leonard, Rensselaer, Mauch Chunk, Pa. (33). Born in Hancock, N. Y., April 12, 1821. Died in Mauch Chunk, Pa., Oct. 26, 1888.

Lewis, Elias, jr., Brooklyn, N. Y. (23). Died Feb. 3, 1894.

Lewis, Henry Carvill, Philadelphia, Pa. (26). Born in Philadelphia, Pa., Nov. 16, 1853. Died in Manchester, England, July 21, 1888.

Libbey, Joseph, Georgetown, D. C. (31). Died July 20, 1886.

Lieber, Oscar Montgomery, Columbia, S. C. (8). Born Sept. 8, 1830. Died June 27, 1862.

Liebig, G. A., Baltimore, Md. (30). Died in Dec., 1893.

Lilly, William, Mauch Chunk, Pa. (28). Born in Penn Yan, N. Y., June 3, 1821. Died in Mauch Chunk, Pa., Dec. 1, 1893.

Lincklaen, Ledyard, Cazenovia, N. Y. (1). Born in Cazenovia, N. Y, Oct. 17, 1820. Died April 25, 1864.

Linsley, James Harvey, Stafford, Conn. (1). Born in Northford, Conn., May 5, 1787. Died in Stratford, Conn., Dec. 26, 1843.

Lockwood, Moses B., Providence, R. I. (9). Died in 1872.

Lockwood, Samuel, Freehold, N. J. (18). Born in Mansfield, England, Jan. 20, 1819. Died Jan. 9, 1894, aged 75.

Logan, William Edmond, Montreal, Canada (1). Born in Montreal, Canada, April 23, 1798. Died in Wales, June 22, 1875.

Loiseau, Emile F., Brussels, Belgium (33). Died April 30, 1886.

Loomis, Elias, New Haven, Conn. (1). Born in Willington, Conn., Aug. 7, 1811. Died in New Haven, Conn., Aug. 15, 1889.

Loosey, Charles F., New York, N. Y. (12).

Lothrop, Joshua R., Buffalo, N. Y. (15).

Lovering, Joseph, Cambridge, Mass. (2). Born in Charlestown, Mass., Dec. 25, 1813. Died in Cambridge, Mass., Jan. 18, 1892.

Lowrie, J. R., Warriorsmark, Pa. (29). Died Dec. 10, 1885.

Lucas, Mrs. John, Philadelphia, Pa. (33). Died May 8, 1893.

Lull, Edward Phelps, Washington, D. C. (28). Born Feb. 20, 1836. Died March 5, 1887.

Lyford, Moses, Springfield, Mass. (22). Born in Mt. Vernon, Me., Jan. 31, 1816. Died in Portland, Me., Aug. 4, 1887.
Lyman, Chester Smith, New Haven, Conn. (4). Born in Manchester, Conn., Jan. 13, 1814. Died in New Haven, Conn., in 1889.
Lyon, Sidney S., Jeffersonville, Ind. (20). Born Aug. 4, 1808. Died June 24, 1872.

M'Conihe, Isaac, Troy, N. Y. (5). Born in Merrimac, N. H., Aug. 22, 1787. Died in Troy, N. Y., Nov. 1, 1867.
McCorkle, Spencer C., Washington, D. C. (33).
McCutchen, A. R., Atlanta, Ga. (25). Died Nov. 21, 1887.
McElrath, Thomas, New York, N. Y. (36). Born in Williamsport, Pa., May 1, 1807. Died in New York, N. Y., June 6, 1888.
McFadden, Thomas, Westerville, Ohio (30). Born Nov. 9, 1825. Died Nov. 9, 1883.
McFarland, Walter, New York, N. Y. (36). Died July 22, 1888.
MacGregor, Donald, Houston, Texas (33). Died in Oct., 1887.
McLachlan, J. S., Montreal, Can. (31).
McMahon, Mathew, Albany, N. Y. (11).
McNaughton, James, Albany, N. Y. (4). Born in Kenmore, Scotland, Dec. 10, 1796. Died in Paris, France, June 11, 1874.
McNaughton, Peter, Albany, N. Y. (10). Born in Kenmore, Scotland, Dec. 6, 1800. Died in Albany, N. Y., Dec. 19, 1875.
McNiel, John A., Binghamton, N. Y. (35). Died in Binghamton, Dec. 20, 1891, aged 75.
Maack, G. A., Cambridge, Mass. (18). Died in Aug., 1873.
Macfarlane, James, Towanda, Pa. (29). Died in 1885.
Mackintosh, James B., New York, N. Y. (27). Died in 1891.
Maffet, Wm. Ross, Wilkes Barre, Pa. (33). Died in June, 1890.
Mahan, Dennis Hart, West Point, N. Y. (9). Born in New York, N. Y., April 2, 1802. Died in New York, Sept. 16, 1871.
Mallery, Garrick, Washington, D. C. (26). Born in Wilkes Barre, Pa., 1831. Died in Washington, D. C., Oct. 24, 1894.
Mallory, Maitland L., Rochester, N. Y. (39). Died April 28, 1894.
March, Alden, Albany, N. Y. (4). Born in Sutton, Mass., Sept. 20, 1795. Died in Albany, N. Y., June 17, 1869.
Marler, George L., Montreal, Can. (31).
Marsh, Dexter, Greenfield, Mass. (1). Born in Montague, Mass., Aug. 22, 1806. Died in Greenfield, Mass., April 2, 1853.
Marsh, James E., Roxbury, Mass. (10).
Martin, Benjamin Nichols, New York, N. Y. (23). Born in Mount Holly, N. J., Oct. 20, 1816. Died in New York, N. Y., Dec. 26, 1883.
Martindale, Isaac C., Camden, N. J. (26). Died Jan. 3, 1893.
Mather, William Williams, Columbus, Ohio (1). Born in Brooklyn, Conn., May 24, 1804. Died in Columbus, Ohio, Feb. 27, 1859.
Maude, John B., St. Louis, Mo. (27). Died in April, 1879.
Maupin, S., Charlottesville, Va. (10).

May, Abigail Williams, Boston, Mass. (29). Born in Boston, April 21, 1829. Died in Boston, Nov. 30, 1888.

Meade, George Gordon, Philadelphia, Pa. (15). Born Dec. 30, 1815. Died Nov. 6, 1872.

Meek, Fielding Bradford, Washington, D. C. (6). Born Dec. 10, 1817. Died Dec. 21, 1876.

Meigs, James Aitken, Philadelphia, Pa. (12). Born July 30, 1829. Died Nov. 9, 1879.

Metcalf, Caleb B., Worcester, Mass. (20). Died July 31, 1891.

Mills, Andrew G., Galveston, Texas (33). Died Feb. 2, 1894.

Minifie, Wm., Baltimore, Md. (12). Born Aug. 14, 1805. Died Oct. 24, 1880.

Mitchel, Ormsby MacKnight, Cincinnati, Ohio (3). Born in Union Co., Ky., July 28, 1810. Died in Beaufort, S. C., Oct. 30, 1862.

Mitchell, Miss Maria, Lynn, Mass. (4). Born in Nantucket, Mass., Aug. 1, 1818. Died in Lynn, 1889.

Mitchell, William, Poughkeepsie, N. Y. (2). Born in Nantucket, Mass., Dec. 20, 1791. Died in Poughkeepsie, N. Y., April 19, 1868.

Mitchell, Wm. H., Florence, Ala. (17).

Mitivier, M. M., Holyoke, Mass. (40). Died in July, 1892.

Monroe, Nathan, Bradford, Mass. (6). Born in Minot, Me., May 16, 1804. Died in Bradford, Mass., July 8, 1866.

Monroe, William, Concord, Mass. (18). Died April 27, 1877.

Monselise, Giulio, Milan, Italy (40). Died Dec. 18, 1894.

Moore, E. C., New York, N. Y. (30).

Morgan, Lewis Henry, Rochester, N. Y. (10). Born near Aurora, N. Y., Nov. 21, 1818. Died Dec. 17, 1881.

Morgan, Mrs. Mary E., Rochester, N. Y. (31). Died in 1884.

Morison, N. H., Baltimore, Md. (17). Born in 1815. Died Nov. 14, 1890.

Morong, Thomas, New York, N. Y. (35). Died in 1894.

Morris, John B., Nashville, Tenn. (26).

Morris, Wistar, Philadelphia, Pa. (33). Died March 23, 1891.

Morton, Samuel George, Philadelphia, Pa. (1). Born in Philadelphia, Pa., Jan. 26, 1799. Died in Philadelphia, May 15, 1851.

Mott, Alexander B., New York, N. Y. (36). Died Aug. 12, 1889.

Mudge, Benjamin Franklin, Manhattan, Kansas (25). Born in Orrington, Me., Aug. 11, 1817. Died Nov. 21, 1879.

Muir, William, Montreal, Can. (31). Died July, 1885.

Mussey, William Heberdom, Cincinnati, Ohio (30). Born Sept. 30, 1818. Died Aug. 1, 1882.

Nagel, Herman, St. Louis, Mo. (30). Born in Tritzwalk, Germany, May 28, 1820. Died in St. Louis, Mo., Feb. 18, 1889.

Nason, Henry Bradford, Troy, N. Y. (13). Born in Foxboro, June 22, 1831. Died Jan., 1895.

Nettleton, Charles, New York, N. Y. (30). Born in Washington, Conn., Oct. 2, 1819. Died in New York, N. Y., May 5, 1892.

Newberry, J. S., New York, N. Y. (5). Died Dec., 1892.

Newland, John, Saratoga Springs, N. Y. (28). Died Jan. 18, 1880.

Newton, E. H., Cambridge, N. Y. (1).

Newton, John, Pensacola, Fla. (7). Born near Pittsburgh, Pa., April 22, 1814. Died in Pensacola, Nov. 25, 1893.

Nichols, Charles A., Providence, R. I. (17). Born Jan. 4, 1826. Died Oct. 20, 1877.

Nichols, William Ripley, Boston, Mass. (18). Born April 30, 1847. Died July 14, 1886.

Nicholson, Thomas, New Orleans, La. (21).

Nicollet, Jean Nicholas, Washington, D. C. (1). Born in Savoy, France, July 24, 1786. Died in Washington, D. C., Sept. 11, 1843.

Northrop, John I., New York, N. Y. (36). Died June 26, 1891.

Norton, John Pitkin, New Haven, Conn. (1). Born July 19, 1822. Died Sept., 5, 1852.

Norton, Lewis Mills, Boston, Mass. (29). Born in Athol, Mass , Dec. 26, 1855. Died in Auburndale, Mass., April 26, 1893.

Norton, William Augustus, New Haven, Conn. (6). Born in East Bloomfield, N. Y., Oct. 25, 1810. Died Sept. 21, 1893.

Noyes, James Oscar, New Orleans, La. (21). Born in Niles, N. Y., June 14, 1829. Died in New Orleans, La., Sept. 11, 1872.

Nutt, Cyrus, Bloomington, Ind. (20). Born in Trumbull Co., Ohio, Sept. 4, 1814. Died in Bloomington, Aug. 23, 1875.

Oakes, William, Ipswich, Mass. (1). Born July 1, 1799. Died July 31, 1848.

Ogden, Robert W., New Orleans, La. (21). Died March 24, 1878.

Ogden, William Butler, High Bridge, N. Y. (17). Born in New York, N. Y., 1805. Died in New York, Aug. 3, 1877.

Oliver, James Edward, Ithaca, N. Y. (7). Born in Portland, Me., July 27, 1829. Died in Ithaca, N. Y., March 27, 1895.

Oliver, Miss Mary E., Ithaca, N. Y. (20).

Olmsted, Alexander Fisher, New Haven, Conn. (4). Born Dec. 20 1822. Died May 5, 1853.

Olmsted, Denison, New Haven, Conn. (1). Born in East Hartford, Conn., June 18, 1791. Died in New Haven, Conn., May 13, 1859.

Olmsted, Denison, jr., New Haven, Conn. (1). Born Feb. 16, 1824. Died Aug. 15, 1846.

Orton, James, Poughkeepsie, N. Y. (18). Born in Seneca Falls, N. Y., April 21, 1830. Died in Peru, S. A., Sept. 24, 1877.

Osbun, Isaac J., Salem, Mass. (29).

Otis, George Alexander, Washington, D. C. (10). Born in Boston, Mass., Nov. 12, 1830. Died Feb. 29, 1881.

Owen, Richard, New Harmony, Ind. (20). Born in Scotland, Jan. 6, 1810. Died in New Harmony, March 24, 1890.

Packer, Harry E., Mauch Chunk, Pa. (30). Died Feb. 1, 1884.

Painter, Jacob, Lima, Pa. (28). Died in 1876.

Painter, Minshall, Lima, Pa. (7).
Parker, Wilbur F., West Meriden, Conn. (28). Died in 1876.
Parkman, Samuel, Boston, Mass. (1). Born in 1816. Died Dec. 15, 1854.
Parry, Charles C., Davenport, Iowa (6). Born in Admington, Worcestershire, Eng., Aug. 28, 1823. Died in Davenport, Iowa, Feb. 20, 1890.
Parsons, Henry Betts, New York, N. Y. (30). Born Nov. 20, 1855. Died Aug. 21, 1885.
Payn, Charles H., Saratoga Springs, N. Y. (28). Born May 16, 1814. Died Dec. 20, 1881.
Pearson, H. G., New York, N. Y. (36).
Pease, F. S., Buffalo, N. Y. (35). Died Nov. 6, 1890.
Pease, Rufus D., Philadelphia, Pa. (33). Died in 1890.
Pedrick, Mrs. William R., Lawrence, Mass. (33). Born Feb. 7, 1832. Died in Lawrence, Jan. 21, 1894.
Peffer, George P., Pewaukee, Wis. (32). Died in Sept., 1894.
Peirce, Benjamin Osgood, Beverly, Mass. (18). Born in Beverly, Sept. 26, 1812. Died in Beverly, Nov. 12, 1883.
Peirce, Benjamin, Cambridge, Mass. (1). Born in Salem, Mass., April 4, 1809. Died in Cambridge, Mass., Oct. 6, 1880.
Perch, Bernard, Frankford, Pa. (35). Born in 1850. Died in 1887.
Perkins, George Roberts, Utica, N. Y. (1). Born in Otsego Co., N. Y., May 3, 1812. Died in New Hartford, N. Y., Aug. 22, 1876.
Perkins, Henry C., Newburyport, Mass. (18). Born Nov. 13, 1804. Died Feb. 2, 1873.
Perry, John B., Cambridge, Mass. (16). Born in 1820. Died Oct. 3, 1872.
Perry, Matthew Calbraith, New York, N. Y. (10). Born in South Kingston, R. I., 1795. Died in New York, March 4, 1858.
Peter, Robert, Lexington, Ky. (29). Born in Cornwall, Eng., Jan. 21, 1805. Died near Lexington, Ky., April 26, 1894.
Phelps, Mrs. Almira Hart Lincoln, Baltimore, Md. (13). Born in Berlin, Conn., July 15, 1793. Died in Berlin, July 15, 1884.
Philbrick, Edw. S., Brookline, Mass. (29). Born in Boston, Mass., Nov. 20, 1827. Died in Brookline, Mass., Feb. 13, 1889.
Phillips, Henry, jr., Philadelphia, Pa. (32). Born in Philadelphia, Pa., Sept. 6, 1833. Died in Philadelphia, Pa., June 6, 1895.
Phillips, John C., Boston, Mass. (29). Born in 1839. Died Mar. 1, 1885.
Piggot, A. Snowden, Baltimore, Md. (10).
Piling, James Constantine, Washington, D. C. (28). Born in Washington, Nov. 16, 1846. Died in Washington, July 26, 1895.
Pim, Bedford Clapperton Trevelyan, London, Eng. (33). Born in England, June 12, 1826. Died Oct., 1886.
Platt, W. G., Philadelphia, Pa. (32). Died Nov., 1885.
Plumb, Ovid, Salisbury, Conn. (9).
Pope, Charles Alexander, St. Louis, Mo. (12). Born in Huntsville, Ala., March 15, 1818. Died in Paris, Mo., July 6, 1870.
Porter, John Addison, New Haven, Conn. (14). Born in Catskill, N. Y., March 15, 1822. Died in New Haven, Conn., Aug. 25, 1866.

Potter, Stephen H., Hamilton, Ohio (30). Born Nov. 10, 1812. Died Dec. 9, 1883.

Pourtalès, Louis François de, Cambridge, Mass. (1). Born March 4, 1824. Died July 19, 1880.

Pruyn, John Van Schaick Lansing, Albany, N. Y. (1). Born in Albany, N. Y., June 22, 1811. Died in Clifton Springs, N. Y., Nov. 21, 1877.

Pugh, Evan, Centre Co., Pa. (14). Born Feb. 29, 1828 Died April 29, 1864.

Pulsifer, Sidney, Philadelphia, Pa. (21). Died March 24, 1884.

Putnam, Mrs. Frederic Ward, Cambridge, Mass. (19). Born in Charlestown, Mass., Dec. 29, 1838. Died in Cambridge, Mass., March 10, 1879.

Putnam, J. Duncan, Davenport, Iowa (27). Born Oct. 18, 1855. Died Dec. 10, 1881.

Quincy, Edmund, Boston, Mass. (11). Died Jan. 6, 1894.

Rauch, John H., Springfield, Ill. (11). Died in Lebanon, Pa., 1894.

Read, Ezra, Terre Haute, Ind. (20). Died in 1877.

Redfield, John H., Philadelphia, Pa. (1). Born in Middletown, Conn., July 10, 1815. Died in Philadelphia, Pa., Feb. 27, 1895.

Redfield, William C., New York, N. Y. (1). Born near Middletown, Conn., March 26, 1789. Died Feb. 12, 1857.

Resor, Jacob, Cincinnati, Ohio (8). Died in 1871.

Reynolds, Sheldon, Wilkes Barre, Pa. (33). Born in Kingston, Pa., Feb. 22, 1845. Died at Saranac Lake, N. Y., Feb. 8, 1895.

Richardson, Tobias G., New Orleans, La. (30). Died in New Orleans, May 26, 1892. Aged 65 years.

Riley, Charles V., Washington, D. C. (17). Born in London, 1843. Died in Washington, Sept. 14, 1895.

Robb, James, Fredericton, N. B. (4).

Robinson, Coleman T., Buffalo, N. Y. (15). Born in Putnam Co., N. Y., in 1838. Died near Brewster's Station, N. Y., May 1, 1872.

Rochester, Thomas Fortescue, Buffalo, N. Y. (35). Born Oct. 8, 1823. Died May 24, 1887.

Rockwell, John Arnold, Norwich, Conn. (10). Born in Norwich, Conn., August 27, 1803. Died in Washington, D. C., February 10, 1861.

Roeder, F. A., Cincinnati, Ohio (30).

Rogers, Henry Darwin, Glasgow, Scotland (1). Born in Philadelphia, Pa., Aug. 1, 1808. Died in Glasgow, Scotland, May 29, 1866.

Rogers, James Blythe, Philadelphia, Pa. (1). Born in Philadelphia, Pa., Feb. 11, 1802. Died in Philadelphia, June 15, 1852.

Rogers, Robert Empie, Philadelphia, Pa. (18). Born in Baltimore, Md., March 29, 1813. Died Sept. 6, 1884.

Rogers, William Barton, Boston, Mass. (1). Born in Philadelphia, Pa., Dec. 7, 1804. Died in Boston, May 30, 1882.

Root, Elihu, Amherst, Mass. (25). Born Sept. 14, 1845.

Rutherford, Lewis M., New York, N. Y. (13). Born in Morrisania, N. Y., Nov. 25, 1816. Died in Tranquillity, N. J., May 30, 1892.

Ryder, John Adams, Philadelphia, Pa. (33). Born near London, Pa., Feb. 29, 1852. Died in Philadelphia, March 26, 1895.

Sager, Abram, Ann Arbor, Mich. (6). Born in Bethlehem, N. Y., Dec. 22, 1811. Died in Ann Arbor, Mich., August 6, 1877.

Sanders, Benjamin D., Wellsburg, W. Va. (19).

Sawyers, Mrs. Alice M. S., Fort Worth, Texas (34). Died April 25, 1893.

Scammon, Jonathan Young, Chicago, Ill. (17). Born in Whitefield, Me., in 1812. Died in Chicago, Ill., March 17, 1890.

Schæffer, George C., Washington, D. C. (1). Died in 1873.

Scherzer, William, Chicago, Ill. (39). Died July 20, 1893.

Schimpff, Robert D., Scranton, Pa. (36).

Schley, William, New York, N. Y. (28). Died in 1882.

Schram, Nicholas Hallock, Newburgh, N. Y. (33). Died in Newburgh, N. Y., aged 54 years, 1 month and 2 days.

Schrenk, Joseph, Hoboken, N. J. (36).

Scott, Joseph, Dunham, C. E. (11). Died in 1865.

Seaman, Ezra Champion, Ann Arbor, Mich. (20). Born Oct. 14, 1805. Died July 15, 1880.

Senecal, L. A., Montreal, Can. (31).

Senter, Harvey S., Aledo, Ill. (20). Died in 1875.

Seward, William Henry, Auburn, N. Y. (1). Born in Florida, N. Y., May 16, 1801. Died in Auburn, N. Y., Oct. 10, 1872.

Seymour, William Pierce, Troy, N. Y. (19). Born in Troy, Oct. 17, 1825. Died in Troy, April 7, 1893.

Sheafer, Peter Wenrich, Pottsville, Pa. (4). Born in Halifax, Pa., March 31, 1819. Died in Brown's Mills in the Pines, N. J., March 26, 1891.

Sheppard, William, Drummondville, Province of Quebec, Can. (11). Born in 1783. Died in 1867.

Sherwin, Thomas, Dedham, Mass. (11). Born in Westmoreland, N. H., March 26, 1799. Died in Dedham, Mass., July 23, 1869.

Sill, Elisha N., Cuyahoga Falls, Ohio (6). Born in 1801. Died April 26, 1888.

Silliman, Benjamin, New Haven, Conn. (1). Born in North Stratford, Conn., August 8, 1779. Died in New Haven, Conn., Nov. 22, 1864.

Silliman, Benjamin, New Haven, Conn. (1). Born in New Haven, Conn., Dec. 4, 1816. Died Jan. 14, 1885.

Simpson, Edward, Washington, D. C. (28). Born in New York, N. Y., March 3, 1824. Died in Washington, D. C., Dec. 1, 1888.

Skilton, Avery Judd, Troy, N. Y. (6). Born in Watertown, Conn., Feb. 1, 1802. Died in Troy, N. Y., March 20, 1858.

Skinner, George, Kalida, Ohio (33).

Skinner, John B., Buffalo, N. Y. (15). Died in 1871.

Slack, J. H., Philadelphia, Pa. (12).

Smith, Charles A., St. Louis, Mo. (27). Died in 1884.

Smith, David P., Springfield, Mass. (29). Born Oct. 1, 1830. Died Dec. 26, 1880.

Smith, Mrs. Erminnie Adelle, Jersey City, N. J. (25). Born April 26, 1836. Died June 9, 1886.

Smith, John Lawrence, Louisville, Ky. (1). Born near Charleston, S. C., Dec. 17, 1818. Died Oct. 12, 1883.

Smith, J. V., Cincinnati, Ohio (5).

Smith, James Young, Providence, R. I. (9). Born in Groton, Conn., Sept. 15, 1809. Died March 26, 1876.

Smith, Lyndon Arnold, Newark, N. J. (9). Born in Haverhill, N. H., November 11, 1795. Died in Newark, N. J., December 15, 1865.

Smucker, Isaac, Newark, Ohio (29).

Snell, Ebenezer Strong, Amherst, Mass. (2). Born in North Brookfield, Mass., October 7, 1801. Died in Amherst, Mass., Sept., 1877.

Sparks, Jared, Cambridge, Mass. (2). Born in Willington, Conn., May 10, 1819. Died in Cambridge, Mass., March 14, 1866.

Spinzig, Charles, St. Louis, Mo. (27). Died Jan. 22, 1882.

Squier, Ephraim George, New York, N. Y. (18). Born in Bethlehem, N. Y., June 17, 1821. Died in Brooklyn, N. Y., Apr. 17, 1888.

Stearns, Josiah A., Boston, Mass. (29).

Stearns, Silas, Pensacola, Fla. (28). Died Aug. 2, 1888.

Steele, Joel Dorman, Elmira, N. Y. (33). Born in Lima, N. Y., May 14, 1836. Died May 25, 1886.

Steiner, Lewis H., Baltimore, Md. (7). Born in Frederick City, Md., in 1827. Died in Baltimore, April, 1892.

Stevenson, James, Washington, D. C. (29). Born in Maysville, Ky., Dec. 24, 1840. Died in New York, N. Y., July 25, 1888.

Stimpson, Wm., Chicago, Ill. (12). Born Feb. 14, 1832. Died May 26, 1872.

Stone, Leander, Chicago, Ill. (32). Died April 2, 1888.

Stone, Samuel, Chicago, Ill. (17). Born Dec. 6, 1798. Died May 4, 1876.

St. John, Joseph S., Albany, N. Y. (28). Died Nov. 23, 1882.

Straight, H. H., Chicago, Ill. (25). Died Nov. 17, 1886.

Sturges, George, Chicago, Ill. (37). Born at Putnam, Ohio, May 13, 1838. Died at Lake Geneva, Wis., Aug. 12, 1890.

Sullivan, Algernon Sidney, New York, N. Y. (36). Born April 5, 1826. Died Dec. 4, 1887.

Sullivant, William Starling, Columbus, Ohio (7). Born near Columbus, O., Jan. 15, 1803. Died in Columbus, O., Apr. 30, 1873.

Sutton, George, Aurora, Ind. (20). Died June 13, 1886.

Swain, James, Fort Dodge, Iowa (21). Born in 1816. Died in 1877.

Swinburne, John, Albany, N. Y. (6). Born in Denmark, N. Y., May 30, 1820. Died in Albany, N. Y., March 28, 1889.

Tallmadge, James, New York, N. Y. (1). Born in Stamford, N. Y., Jan. 20, 1778. Died in New York, N. Y., Oct. 3, 1853.

Taylor, Arthur F., Cleveland, Ohio (29). Born Dec. 10, 1853. Died June 28, 1883.

Taylor, Richard Cowling, Philadelphia, Pa. (1). Born in England, Jan. 18, 1789. Died in Philadelphia, Pa., November 26, 1851.

Taylor, Robert N., Tollesboro, Ky. (37). Died Aug. 13, 1888.
Taylor, William B., Washington, D. C. (29). Died in Feb., 1895.
Tenney, Sanborn, Williamstown, Mass. (17). Born in January, 1827. Died July 11, 1877.
Teschemacher, James Englebert, Boston, Mass. (1). Born in Nottingham, England, June 11, 1790. Died near Boston, Nov. 9, 1853.
Thompson, A. Remsen, New York, N. Y. (1). Died in Oct., 1879.
Thompson, Alexander, Aurora, N. Y. (1).
Thompson, Charles Oliver, Terre Haute, Ind. (29). Born in East Windsor Hill, Conn., Sept. 25, 1835. Died in Terre Haute, Ind., March 17, 1885.
Thompson, Harvey M., Oakland, Cal. (17).
Thompson, Zadock, Burlington, Vt. (1). Born in Bridgewater, Vt., May 23, 1796. Died in Burlington, Vt., Jan. 19, 1856.
Thomson, Henry R., Crawfordsville, Ind. (30). Died in 1884.
Thorn, James, Troy, N. Y. (10). Born in Colchester, Eng., July 20, 1802.
Thurber, Isaac, Providence, R. I. (9).
Tileman, John Nicholas, Sandy, Utah (33). Born in Horhun, Denmark, March 28, 1845. Died in Salt Lake City, Utah, Sept. 4, 1888.
Tillman, Samuel Dyer, Jersey City, N. J. (15). Born April, 1815. Died Sept. 4, 1875.
Tobin, Thomas W., Louisville, Ky. (30). Died Aug. 4, 1883.
Todd, Albert, St. Louis, Mo. (27). Born March 4, 1813. Died April 30, 1885.
Tolderoy, James B., Fredericton, N. B. (11).
Torrey, John, New York, N. Y. (1). Born in New York, N. Y., Aug. 15, 1796. Died in New York, March 10, 1873.
Torrey, Joseph, Burlington, Vt. (2). Born in Rowley, Mass., Feb. 2, 1797. Died in Burlington, Vt., Nov. 26, 1867.
Totten, Joseph Gilbert, Washington, D. C. (1). Born in New Haven, Conn., August 23, 1788. Died in Washington, D. C., April 22, 1864.
Townsend, Howard, Albany, N. Y. (10). Born Nov. 22, 1823. Died Jan. 6, 1867.
Townsend, John Kirk, Philadelphia, Pa. (1). Born Aug. 10, 1809. Died Feb. 16, 1851.
Townsend, Robert, Albany, N. Y. (9). Born 1799. Died Aug. 15, 1866.
Townshend, Norton S., Columbus, Ohio. (17). Born in England in 1815. Died July 13, 1895.
Trembley, J. B., Oakland, Cal. (17).
Troost, Gerard, Nashville, Tenn. (1). Born in Bois-le-Duc, Holland, March 15, 1776. Died in Nashville, Tenn., Aug. 14, 1850.
Trowbridge, William Pettit, New Haven, Conn. (10). Born in Troy, Mich., in 1828. Died in New Haven, Aug. 12, 1892.
Tuomey, Michæl, Tuscaloosa, Ala. (1). Born in Ireland, September 29, 1805. Died in Tuscaloosa, Ala., March 20, 1857.
Tupper, Samuel Y., Charleston, S. C. (38). Died in 1891.
Tweedale, John B., St. Thomas, Can. (35). Born in Ormskirk, Lancashire, Eng., Oct. 16, 1821. Died in St. Thomas, Can., Nov. 18, 1889.

Tyler, Edward R., New Haven, Conn. (1). Born Aug. 3, 1800. Died Sept. 28, 1848.

Tyler, Edward R., Washington, D. C. (31). Died in Washington, March 30, 1891.

Vancleve, John W., Dayton, Ohio (1).

Van der Weyde, Peter H., N. Y. (17). Born in Nymegen, Holland, in 1813. Died in Brooklyn, N. Y., March 17, 1895.

Vanuxem, Lardner, Bristol, Pa. (1). Born in Philadelphia, Pa., July 23, 1792. Died in Bristol, Pa., June 25, 1848.

Vasey, George, Washington, D. C. (32). Died in Washington, March 4, 1893.

Vaux, William Sanson, Philadelphia, Pa. (1). Born in Philadelphia, May 19, 1811. Died in Philadelphia, May 5, 1882.

Wadsworth, James Samuel, Genesee, N. Y. (2). Born in Genesee, N. Y., October 30, 1807. Died near Chancellorsville, Va., May 8, 1864.

Wagner, Tobias, Philadelphia, Pa. (9).

Walker, J. R., Bay Saint Louis, Miss. (19). Born Aug. 7, 1830. Died June 22, 1887.

Walker, Joseph, Oxford, N. Y. (10).

Walker, Sears C., Washington, D. C. (1). Born March 28, 1805. Died January 30, 1853.

Walker, Timothy, Cincinnati, Ohio (4). Born in Wilmington, Mass., Dec. 1, 1802. Died in Cincinnati, Ohio, Jan. 15, 1856.

Walling, H. F., Cambridge, Mass. (16). Died April 8, 1888.

Walsh, Benjamin D., Rock Island, Ill. (17). Born in Frome, England, Sept. 21, 1808. Died in Rock Island, Ill.. Nov. 18, 1869.

Walton, Joseph J., Philadelphia, Pa. (29). Born in Barnesville, Ohio, Nov. 1, 1855. Died in Philadelphia, Pa , Oct. 11, 1889.

Walton, Joseph R., Washington, D. C. (40). Died Sept. 23, 1892.

Wanzer, Ira, Brookfield, Conn. (18). Born in New Fairfield, Conn., April 17, 1796. Died in New Milford, Conn., March 5, 1879.

Warnecke, Carl, Montreal, Can. (31). Died May 14, 1886.

Warren, Cyrus M., Brookline, Mass. (29). Died Aug. 13, 1891.

Warren, Geo. Washington, Boston, Mass. (18). Died in 1884.

Warren, Gouverneur Kemble, Newport, R. I. (12). Born in Cold Spring, N. Y., Jan. 8, 1830. Died in Newport, R. I., Aug. 8, 1882.

Warren, John Collins, Boston, Mass. (1). Born in Boston, Mass , Aug. 1, 1778. Died in Boston, May 4, 1856.

Warren, Samuel D., Boston, Mass. (29). Born in 1817. Died May 11, 1888.

Waters, Edwin Forbes, Boston, Mass. (29). Born in Petersham, Mass., in July, 1822. Died in San Francisco, Cal., April 18, 1894.

Watertown, Charles, Wakefield, Eng. (1). Born in Wakefield, England. Died in Wakefield, May 26, 1865.

Watkins, Samuel, Nashville, Tenn. (26).

Watson, James Craig, Ann Arbor, Mich. (13). Born in Fingal, Canada, Jan. 28, 1838. Died in Madison, Wis., Nov. 23, 1880.

Watson, Sereno, Cambridge, Mass. (22). Died March 9, 1892, in the 66th year of his age.

Webster, Horace B., Albany, N. Y. (1). Born in 1812. Died Dec. 8, 1843.

Webster, J. W., Cambridge, Mass. (1). Born in 1793. Died Aug. 30, 1850.

Webster, M. H., Albany, N. Y. (1).

Weed, Monroe, Wyoming, N. Y. (6). Died in 1867.

Welch, Mrs. G. O., Lynn, Mass. (21). Died in June, 1882.

Welsh, John, Philadelphia, Pa. (33). Died May, 1886.

Weyman, George W., Pittsburgh, Pa. (6). Born April, 1832. Died July 16, 1864.

Wheatland, Henry, Salem, Mass. (1). Born in Salem, Jan. 11, 1812. Died in Salem, Feb. 27, 1893.

Wheatland, Richard H., Salem, Mass. (13). Born July 6, 1830. Died Dec. 21, 1863.

Wheatley, Charles M., Phœnixville, Pa. (1). Died May 6, 1882.

Wheeler, Arthur W., Baltimore, Md. (29). Born in March, 1859. Died Jan. 6, 1881.

Wheildon, Alice W., Concord, Mass. (31). Died June 16, 1893.

Wheildon, William W., Concord, Mass. (13). Born in 1805. Died in Concord, Mass., Jan. 7, 1892.

Whelen, Edward S., Philadelphia, Pa. (33). Died Feb. 14, 1894.

Whitall, Henry, Camden, N. J. (33).

White, Samuel S., Philadelphia, Pa. (23). Died Dec. 30, 1879.

Whiting, Lewis E., Saratoga Springs, N. Y. (28). Born March 7, 1815. Died Aug. 2, 1882.

Whitman, Edmund B., Cambridge, Mass. (29). Died Sept. 2, 1883.

Whitman, Wm. E., Philadelphia, Pa. (23). Died in 1875.

Whitney, Asa, Philadelphia, Pa. (1). Born Dec. 1, 1791. Died June 4, 1874.

Whittlesey, Charles, Cleveland, Ohio (1). Born in Southington, Conn., Oct. 5, 1808. Died Oct. 18, 1886.

Whittlesey, Charles C., St. Louis, Mo. (11). Died in 1872.

Wight, Orlando W., Detroit, Mich. (34).

Wilber, G. M., Pine Plains, N. Y. (19).

Wilder, Graham, Louisville, Ky. (30). Born July 1, 1843. Died Jan. 16, 1885.

Willard, Emma C. Hart, Troy, N. Y. (15). Born in Berlin, Conn., Feb. 23, 1787. Died in Troy, N. Y., April 15, 1870.

Williams, Frank, Buffalo, N. Y. (25). Died Aug. 13, 1884.

Williams, George Huntington, Baltimore, Md. (33). Died in Utica, N. Y., July, 1894.

Williams, Henry W., Boston, Mass. (11). Born in Boston, Dec. 11, 1821, Died June 13, 1895.

Williams, J. Francis, Salem, N. Y. (31). Died in 1891.

Williams, P. O., Watertown, N. Y. (24).

Williamson, Robert S., San Francisco, Cal. (12). Born in New York about 1825.

Wilson, C. H., Belize, British Honduras (30).

Wilson, Daniel, Toronto, Can. (25). Born in Edinburgh, Scotland. Died in Toronto, Aug., 1892.

Wilson, Mrs. Mary V. C., Mobile, Ala. (37). Born in Morengo County, Ala., Jan. 29, 1840. Died near Tullahoma, Tenn., June 24, 1889.

Wilson, W. C., Carlisle, Pa. (12).

Winchell, Alexander, Ann Arbor, Mich. (3). Born in North East, N. Y., Dec. 31, 1824. Died in Ann Arbor, Mich., Feb. 19, 1891.

Winlock, Joseph, Cambridge, Mass. (5). Born in Shelbyville, Ky., Feb. 6, 1826. Died in Cambridge, Mass., June 11, 1875.

Woerd, Chas. Vander, Waltham, Mass. (29). Born in Leyden, Holland, Oct. 6, 1821. Died near Dagget, Cal., Dec. 29, 1888.

Wood, Robert W., Jamaica Plain, Mass. (29).

Woodbury, Levi, Portsmouth, N. H. (1). Born in Francistown, N. H., Dec. 22, 1789. Died Sept. 4, 1851.

Woodman, John Smith, Hanover, N. H. (11). Born in Durham, N. H., Sept. 6, 1819. Died in Durham, N. H., May 15, 1871.

Woodward, A. E., Jefferson City, Mo. (39). Died in Montana, Sept. 20, 1891.

Woodward, Joseph Janvier, Washington, D. C. (28). Born in Philadelphia, Pa., Oct. 30, 1833. Died near that city, Aug. 17, 1884.

Worthen, Amos Henry, Springfield, Ill. (5). Born Oct. 31, 1813. Died May 6, 1888.

Worthington, George, New York, N. Y. (36). Died Feb. 1, 1892.

Wright, Elizur, Boston, Mass. (31). Born in South Canaan, Conn., Feb. 12, 1804. Died Nov. 20, 1885.

Wright, Harrison, Wilkes Barre, Pa. (29). Born July 15, 1850. Died Feb. 20, 1885.

Wright, John, Troy, N. Y. (1). Born in Troy, N. Y., Feb. 2, 1811. Died in Aiken, S. C., April 11, 1846.

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Wyckoff, William Cornelius, New York, N. Y. (20). Born in New York, N. Y., May 28, 1832. Died in Brooklyn, N. Y., May 2, 1888.

Yarnall, M., Washington, D. C. (26). Born in 1817. Died Jan. 27, 1879.

Youmans, Edward Livingston, New York, N. Y. (6). Born in Coeymans, N. Y., June 3, 1821. Died Jan. 18, 1887.

Young, Ira, Hanover, N. H. (1). Born in Lebanon, N. H., May 23, 1801. Died in Hanover, N. H., Sept. 14, 1858.

Zentmayer, Joseph, Philadelphia, Pa. (29). Died, 1887.

ADDRESS

BY

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THE RETIRING PRESIDENT OF THE ASSOCIATION.

THE AIMS OF ANTHROPOLOGY.

A MODERN philosopher has advanced the maxim that what is first in thought is last in expression; illustrating it by the rules of grammar, which are present even in unwritten languages, whose speakers have no idea of syntax or parts of speech.[1]

It may be that this is the reason why man, who has ever been the most important creature to himself in existence, has never seriously and to the best of his abilities made a study of his own nature, its wants and its weaknesses, and how best he could amend the one and satisfy the other.

The branch of human learning which undertakes to do this is one of the newest of the sciences; in fact, it has scarcely yet gained admission as a science at all, and is rather looked upon as a dilettante occupation, suited to persons of elegant leisure and retired old gentlemen, and without any very direct or visible practical applications or concern with the daily affairs of life.

It is with the intention of correcting this prevalent impression that I address you to-day. My endeavor will be to point out both the immediate and remote aims of the science of Anthropology, and to illustrate by some examples the bearings they have, or surely soon will have, on the thoughts and acts of civilized communities and intelligent individuals.

It is well at the outset to say that I use the term anthropology

[1] Professor James Ferrier, in his *Institutes of Metaphysic*.

in the sense in which it has been adopted by this Association, that is, to include the study of the whole of man, his psychical as well as his physical nature, and the products of all his activities, whether in the past or in the present. By some writers, especially on the continent of Europe, the term anthropology is restricted to what we call physical anthropology or somatology, a limitation of the generic term which we cannot but deplore. Others again, and some of worthy note, would exclude from it the realm of history, confining it, in time, to the research of prehistoric epochs, and in extent, to the investigation of savage nations.

I cannot too positively protest against such opinions. Thus "cabinned, cribbed, confined," it could never soar to that lofty eminence whence it could survey the whole course of the life of the species, note the development of its inborn tendencies, and mark the lines along which it has been moving since the first syllables of recorded time; for this, and nothing less than this, is the bold ambition toward which aspires this crowning bough of the tree of human knowledge.

You will readily understand from this the magnitude of the material which anthropology includes within its domain. First, it investigates the physical life of man in all its stages and in every direction. While he is still folded in the womb, it watches his embryonic progress through those lower forms, which seem the reminiscences of far-off stages of the evolution of the species, until the child is born into the world, endowed with the heritage transmitted from innumerable ancestors and already rich in personal experiences from its prenatal life. These combined decide the individual's race and strain, and potently incline, if they do not absolutely coerce, his tastes and ambitions, his fears and hopes, his failure or success.

On the differences thus brought about, and later nourished by the environment, biology, as applied to the human species, is based; and on them as expressed in aggregates, ethnography, the separation of the species into its sub-species and smaller groups, is founded. It has been observed that numerous and persistent although often slight differences arose in remote times, independently, on each of the great continental areas, sufficient to characterize with accuracy these sub-species. We therefore give to such the terms "races" or "varieties" of man.

All these are the physical traits of man. They are studied by the

anatomist, the embryologist, the physician; and the closest attention to them is indispensable, if we would attain a correct understanding of the creature Man, and his position in the chain of organic life.

But there is another vast field of study wholly apart from this and even more fruitful in revelations. It illustrates man's mental or psychical nature, his passions and instincts, his emotions and thoughts, his powers of ratiocination, volition and expression. These are preserved and displayed subjectively in his governments and religions, his laws and his languages, his words and his writings; and, objectively, in his manufactures and structures, in the environment which he himself creates,—in other words, in all that which we call the arts, be they "hooked to some useful end," or designed to give pleasure only.

It is not sufficient to study these as we find them in the present. We should learn little by such a procedure. What we are especially seeking is to discover their laws of growth, and this can only be done by tracing these outward expressions of the inward faculties step by step back to their incipiency. This leads us inevitably to that branch of learning which is known as archæology, "the study of ancient things," and more and more to that part of archæology called prehistoric, for that concerns itself with the most ancient; and the most ancient is the simplest, and the simplest is the most transparent, and therefore the most instructive.

Prehistoric archæology is a new science. I can remember when neither its name nor its methods were known to the most learned anthropologists. But it has already taught us by incontrovertible arguments a wonderful truth, a truth opposing and reducing to naught many teachings of the sages and seers of past generations. They imagined that the primal man had fallen from some high estate; that he had forfeited by his own falseness, or been driven by some hard fate, from a pristine Paradise, an Eden garden, an Arcady; that his ancestors were demi-gods and heroes, himself their degenerate descendant.

How has prehistoric archæology reversed this picture! We know beyond cavil or question that the earliest was also the lowest man, the most ignorant, the most brutish, naked, homeless, half-speechless. But the gloom surrounding this distant background of the race is relieved by rays of glory; for with knowledge not less positive are we assured that through all hither time, through seeming retrogressions and darkened epochs, the advance of the

race in the main toward a condition better by every standard has been certain and steady, "ne'er known retiring ebb, but kept due on."

Archæology, however, is, after all, a dealing with dry bones, a series of inferences from inamimate objects. The color and the warmth of life, it never has. How can we divine the real meaning of the fragments and ruins, the forgotten symbols and the perished gods, it shows us?

The means has been found, and this through a discovery little less than marvelous, the most pregnant of all that anthropology has yet offered, not yet appreciated even by the learned. This discovery is that of the psychical unity of man, the parallelism of his development everywhere and in all time; nay, more, the nigh absolute uniformity of his thoughts and actions, his aims and methods, when in the same degree of development, no matter where he is, or in what epoch living. Scarcely anything but his geographical environment, using that term in its larger sense, seems to modify the monotonous sameness of his creations.

I shall refer more than once to this discovery; for its full recognition is the corner stone of true anthropology. In this connection I refer to it for its application to archæology. It teaches us this: that when we find a living nation of low culture, we are safe in taking its modes of thought and feeling as analogous to those of extinct tribes whose remains show them to have been in about the same stage of culture.

This emphasizes the importance of a prolonged and profound investigation of the few savage tribes who still exist; for, although none of them is as rude or as brute-like as primitive man, they stand nearest to his condition, and, moreover, so rapid nowadays is the extension of culture, that probably not one of them will remain untouched by its presence another score of years.

Another discovery, also very recent, has enabled us to throw light on the prehistoric or forgotten past. We have found that much of it, thought to be long since dead, is still alive and in our midst, under forms easily enough recognized when our attention is directed to them. This branch of anthropology is known as Folk-lore. It investigates the stories, the superstitions, the beliefs and customs which prevail among the unlettered, the isolated and the young; for these are nothing less than survivals of the mythologies, the legal usages and the sacred rites of earlier generations.

It is surprising to observe how much of the past we have been able to reconstruct from this humble and long neglected material.

From what I have already said, you will understand some of the aims of anthropology, those which I will call its "immediate" aims. They are embraced in the collection of accurate information about man and men, about the individual and the group, as they exist now, and as they have existed at any and all times in the past; here where we are, and on every continent and island of the globe.

We desire to know about a man, his weight and his measure, the shape of his head, the color of his skin and the curl of his hair; we would pry into all his secrets and his habits, discover his deficiencies and debilities, learn his language, and inquire about his politics and his religion, yes, probe those recesses of his body and his soul which he conceals from wife and brother. This we would do with every man and every woman, and, not content with the doing it, we would register all these facts in tables and columns, so that they should become perpetual records, to which we give the name "vital statistics."

The generations of the past escape such personal investigation, but not our pursuit. We rifle their graves, measure their skulls, and analyze their bones, we carry to our museums the utensils and weapons, the gods and jewels, which sad and loving hands laid beside them, we dig up the foundations of their houses and cart off the monuments which their proud kings set up. Nothing is sacred to us; and yet nothing to us is vile or worthless. The broken potsherd, the half-gnawed bone, cast on the refuse heap, conveys a message to us more pregnant with meaning, more indicative of what the people were, than the boastful inscription which their king caused to be engraved on royal marble.

This gleaning and gathering, this collecting and storing of facts about man from all quarters of the world and all epochs of his existence, is the first and indispensable aim of anthropologic science. It is pressing and urgent beyond all other aims at this period of its existence as a science; for here more than elsewhere we feel the force of the Hippocratic warning, that the time is short and the opportunity fleeting. Every day there perish priceless relics of the past, every year the languages, the habits and the modes of thought of the surviving tribes which represent the earlier condition of the whole species, are increasingly transformed and lost through the extension of civilization. It devolves on the

scholars of this generation to be up and doing in these fields of research; for those of the next will find many a chance lost forever, of which we can avail ourselves.

And here let me insert a few much needed words of counsel on this portion of my theme. Why is it that even in scientific circles so little attention is paid to the proper training of observers and collectors in anthropology?

We erect stately museums, we purchase costly specimens, we send out expensive expeditions; but where are the universities, the institutions of higher education, who train young men how to observe, how to explore and collect in this branch? As an eminent ethnologist has remarked, in any other department of science, in that, for instance, which deals with flowers or with butterflies, no institution would dream of sending a collector into the field who lacked all preliminary training in the line, or knowledge of it; but in anthropology the opinion seems universal that such preparation is quite needless.[1] Carlyle used to say that every man feels himself competent to be a gentleman farmer or a crown prince; our institutions seem to think that every man is competent to be an anthropologist and archæologist; and let a plausible explorer present himself, the last question put to him will be, whether he has any fitness for the job.

Hence our museums are crammed with doubtful specimens, vaguely located, and our volumes of travel with incomplete or wholly incorrect statements, worse than purely fictitious ones, because we know them to be the fruit of honest intentions, and therefore give them credit.

But, you will naturally ask, to what end this accumulating and collecting, this filling of museums with the art-products of savages and the ghastly contents of charnel houses? Why write down their stupid stories and make notes of their obscene rites? When it shall be done, or as good as done, what use can be made of them beyond satisfying a profitless curiosity?

This leads me to explain another branch of anthropology to which I have not yet alluded, one which introduces us to other aims of this science, quite distinct from those I have mentioned. That branch is Ethnology.

[1] See the pertinent remarks of Dr. S. R. Steinmetz in the Einleitung to his *Ethnologische Studien zur Ersten Entwicklung der Strafe* (Leiden, 1894). I have urged this point further in a pamphlet entitled *Anthropology: as a Science and as a branch of University Education in the United States.* (Philadelphia, 1892.)

Ethnology in its true sense represents the application of the principles of inductive philosophy to the products of man's faculties. You are aware that that philosophy proceeds from observed facts alone; it discards all preconceived opinions concerning these facts; it renounces all allegiance to dogma, or doctrine or intuition; in short, to every form of statement that is not capable of verification. Its method of procedure is by comparison, that is, by the logical equations of similarity and diversity, of identity and difference; and on these it bases those generalizations which range the isolated fact under the general law, of which it is at once the exponent and the proof.

By such comparisons, ethnology aims to define in clear terms the influence which the geographical and other environment exercises on the individual, the social group and the race; and, conversely, how much in each remains unaltered by the external forces, and what residual elements are left, defiant of surroundings, wholly personal, purely human. Thus, rising to wider and wider circles of observation and generalization, it will be able at last to offer a conclusive and exhaustive connotation of what man is,—a necessary preliminary, mark you, to that other question, so often and so ignorantly answered in the past, as to what he should be.

Ethnology, however, does not and should not concern itself with this latter inquiry. Its own field is broad enough, and the harvest offered is rich enough. Its materials are drawn from the whole of history and from pre-history. Those writers who limit its scope to the explanation of the phenomena of primitive social life only, have so done because these phenomena are simpler in such conditions, not that the methods of ethnology are applicable only to such. On the contrary, they are not merely suitable, they are necessary to all the facts of history, if we would learn their true meaning and import. The time will come, and that soon, when sound historians will adopt as their guide the principles and methods of ethnologic science, because by these alone can they assign to the isolated fact its right place in the vast structure of human development.

In the past, histories have told of little but of kings and their wars; some writers of recent date have remembered there is such a thing as the People, and have essayed to present its humble annals; but how few have even attempted to avail themselves of the myriad side-lights which ethnology can throw on the motives and the manners of a people, its impulses and acquisitions?

It is the constant aim of ethnology to present its results free from bias. It deprecates alike enthusiasm and antipathy. Like Spinoza's God, *nullum amat*, *nullum odit*. Its aim is to compare dispassionately all the acts and arts of man, his philosophies and religions, his social schemes and personal plans, weighing and analyzing them, separating the local and temporal in them from the permanent and general, explaining the former by the conditions of time and place, referring the latter to the category of qualities which make up the oneness of humanity, the solid ground on which he who hereafter builds, "will build for aye."

This, then, briefly stated, is the aim of that department of anthropology which we call ethnology. In yet fewer words, its mission is "to define the universal in humanity," as distinguished from all those traits which are the products of fluctuating environments.

This universal, however, is to be discovered, not assumed. The fatal flaw in the arguments of most philosophers, is that they frame a theory of what man is and what are the laws of his growth, and pile up proofs of these, neglecting the counter-evidence, and passing in silence what contradicts their hypotheses.

Take, for instance, the doctrine of evolution as applied to man. It is not only a doctrine but a dogma with many scientists. They look with theological ire on any one who questions it. I have already said that in the long run and the general average it has been true of man. But that we have any certainty that it will continue true, is a mistake; or that it has been true of the vast majority of individuals or ethnic groups, is another mistake. As the basis for a boastful and confident optimism it is as shaky as sand. Taken at its real value, as the provisional and partial result of our observations, it is a useful guide; but swallowed with unquestioning faith as a final law of the universe, it is not a whit more inspiring than the narrowest dogma of religious bigotry.

We have no right, indeed, to assume that there is anything universal in humanity until we have proved it. But this has been done. Its demonstration is the last and greatest conquest of ethnology, and it is so complete as to be bewildering. It has been brought about by the careful study of what are called "ethnographic parallels," that is, similarities or identities of laws, games, customs, myths, arts, etc., in primitive tribes located far asunder on the earth's surface. Able students, such as Bastian, Andree, Post, Steinmetz and others have collected so many of these par-

allels, often of seemingly the most artificial and capricious character, extending into such minute and apparently accidental details from tribes almost antipodal to each other on the globe, that Dr. Post does not hesitate to say: "Such results leave no room for doubt that the psychical faculties of the individual as soon as they reach outward expression fall under the control of natural laws as fixed as those of inorganic nature."[1]

As the endless variety of arts and events in the culture history of different tribes in different places, or of the same tribe at different epochs, illustrates the variables in anthropologic science, so these independent parallelisms prove beyond cavil the ever-present constant in the problem, to wit, the one and unvarying psychical nature of man, guided by the same reason, swept by the same storms of passion and emotion, directed by the same will toward the same goals, availing itself of the same means when they are within reach, finding its pleasure in the same actions, lulling its fears with the same sedatives.

The anthropologist of to-day who, like a late distinguished scholar among ourselves, would claim that because the rather complex social system of the Iroquois had a close parallel among the Munda tribes of the Punjab, therefore the ancestors of each must have come from a common culture center; or, who, like an eminent living English ethnologist, sees a proof of Asiatic relations in American culture because the Aztec game of *patolli* is like the East Indian game of *parchesi*,—such an anthropologist, I say, may have contributed ably to his science in the past, but he does not know where it stands to-day. Its true position on this crucial question is thus tersely and admirably stated by Dr. Steinmetz:—"The various customs, institutions, thoughts, etc., of different peoples are to be regarded either as the expressions of the different stadia of culture of our common humanity; or, as different reactions of that common humanity under varying conditions and circumstances. The one does not exclude the other. Therefore the concordance of two peoples in a custom, etc., should be explained by borrowing or by derivation from a common source only when there are special, known and controlling reasons indicating this; and when these are absent, the explanation should be either because the two peoples are on the same plane of culture, or because their surroundings are similar."[2]

[1] Dr. A. H. Post, "Ethnologische Gedanken," in *Globus*, Band 59, No. 19.
[2] Dr. S. R. Steinmetz, ubi supra, Einleitung.

This is true not only of the articles intended for use, to supply the necessities of existence, as weapons and huts and boats,—we might anticipate that they would be something similar, otherwise they would not serve the purpose everywhere in view; but the analogies are, if anything, still more close and striking when we come to compare pure products of the fancy, creations of the imagination or the emotions, such as stories, myths, and motives of decorative art.

It has proved very difficult for the comparative mythologist or the folk-lorist of the old school to learn that the same stories, for instance, of the four rivers of Paradise, the flood, the ark and the patriarch who is saved in it, arose independently in Western Asia, in Mexico and in South America, as well as in many intervening places, alike even in details, and yet neither borrowed one from the other, nor yet drawn from a common source. But until he understands this, he has not caught up with the progress of ethnologic science.

So it is also with the motives of primitive art, be they symbolic or merely decorative. How many volumes have been written tracing the migrations and connections of nations by the distribution of some art motive, say the *svastika*, the maeander or the cross! And how little of value is left in all such speculations by the rigid analysis of primitive arts that we see in such works as Dr. Grosse's *Anfänge der Kunst*, or Dr. Haddon's attractive monograph on the "Decorative Art of British New Guinea," published last year! The latter sums up in these few and decisive words the result of such researches pursued on strictly inductive lines,—"The same processes operate on the art of decoration whatever the subject, wherever the country, whenever the age." This is equally true of the myth and the folk-tale, of the symbol and the legend, of the religious ritual and the musical scale.

I have even attempted, I hope not rashly, to show that there are quite a number of important words in languages nowise related by origin or contact, which are phonetically the same or similar, not of the mimetic class, but arising from certain common relations of the physiological function of language; and I have urged that words of this class should not be accounted of value in studying the affiliations of languages.[1]

And I have also endeavored to demonstrate that the sacredness

[1] "On the Physiological Correlation of certain Linguistic Radicals." By D. G. Brinton. In the *Proceedings* of the American Oriental Society, March, 1894.

which we observe attached to certain numbers, and the same numbers, in so many mythologies and customs the world over, is neither fortuitous, nor borrowed the one from the other; but depends on fixed relations which the human body bears to its surroundings, and the human mind to the laws of its own activity. And therefore, that all such coincidences and their consequences—and it is surprising how far-reaching these are—do not belong to the similarities which reveal contact, but only to those which testify to psychical unity.[1]

So numerous and so amazing have these examples of culture-identities become of late years that they have led more than one student of ethnology into a denial of the freedom of the human will under any of the definitions of voluntary action. But the aims of ethnology are not so aspiring. It is strictly a natural science, dealing with outward things, to wit, the expressions of man's psychical life, endeavoring to ascertain the conditions of their appearance and disappearance, the organic laws of their birth, growth and decay. These laws must undoubtedly be correlated with certain mental traits, but it is not the business of the ethnologist to pursue them to their last analysis in the realm of metaphysics. For instance, we may trace all forms of punishment back to the individual's passion for revenge; or we may analyze all systems of religion until we find the common source of all to be man's dread of the unknown; and these will be sufficient ethnologic explanations of both these phenomena; but not a final analysis of the emotion of dread or the thirst for vengeance. Ethnology declines to enter these realms of abstractions.

I repeat that to define "the universal in humanity" is the aim of ethnology, that is, the universal soul or *psyche* of humanity.

But let me not be understood as speaking of this as of some entity, like the *ame humaine* of the Comtists. That were sophistical word-mongering in the style of ancient scholasticism. There is no such entity as humanity, or race, or people, or nation. There is nothing but the individual man or woman, the "single, separate person," as Walt Whitman says. Hence some of the most advanced ethnologists are ready to give up the *ethnos* itself as a subject of study. Those terms so popular a few years ago, *Völkerpschykologie*,

[1] "The Origin of Sacred Numbers." By D. G. Brinton. In the *American Anthropologist*, April, 1894. In my *Myths of the New World* (New York, 1868, Chapter III, "The Sacred Number, its Origin and Applications"), I had shown the prepotency of the number *four* both in American and Old World mythology, ritual, statecraft, etc.

Völkergedanken, racial psychology, ethnic sentiments, and the like, are looked upon with distrust. The external proofs of the psychical unity of the whole species have multiplied so abundantly that some maintain strenuously that it is not ethnic or racial peculiarities, but solely external conditions on the one hand and individual faculties on the other, which are the factors of culture-evolution.

While I admit that this question is still *sub judice*, I add that the position just stated seems to be erroneous. All members of the species have common human mental traits; that goes without saying; and in addition it seems to me that each of the great races, each ethnic group, has its own added special powers and special limitations compared with the others; and that these ethnic and racial psychic peculiarities attached to all or nearly all members of the group are tremendously potent in deciding the result of its struggle for existence.

I must still deny that all races are equally endowed,—or that the position with reference to civilization which the various ethnic groups hold to-day, is one merely of opportunity and externalities. I must still claim that the definition of the *ethnos* is one of the chief aims of ethnology; and that the terms of this definition are not satisfied by geographic explanations. Let me, with utmost brevity, name a few other connotations, prepotent, I believe, in the future fate of nations and races.

None, I maintain, can escape the mental correlations of its physical structure. The black, the brown and the red races differ anatomically so much from the white, especially in their splanchnic organs, that even with equal cerebral capacity, they never could rival its results by equal efforts.

Again, there is in some stocks and some smaller ethnic groups a peculiar mental temperament, which has become hereditary and general, of a nature to disqualify them for the atmosphere of modern enlightenment. Dr. Von Buschan has recently pointed out this as distinctly and racially pathologic; an inborn morbid tendency, constitutionally recreant to the codes of civilization, and therefore technically criminal.

Once more, one cannot but acknowledge that the relations of the emotional to the intellectual nature vary considerably and permanently in different ethnic groups. Nothing is more incorrect than the statement so often repeated by physicians that the modern civilized man has a more sensitive emotional system than the

savage. The reverse is the case. Since the Dark Ages, Europe has not witnessed epidemic neuroses so violent as those still prevalent among rude tribes.

These and a number of similar traits separate races and peoples from each other by well marked idiosyncrasies, extending to the vast majority of their members and pregnant with power for weal or woe on their present fortunes and ultimate destinies. The patient and thorough investigations of these peculiarities is, therefore, one of the most apposite aims of modern ethnology.

In this sense we can speak of the *Volksgeist* and *Völkergedanken*, a racial mind, or the temperament of a people, with as much propriety and accuracy as we can of any of the physical traits which distinguish it from other peoples or races.

For the branch of anthropology which has for its field the investigation of these general mental traits, the Germans have proposed the name "Characterology" (*Karacterologie*). Its aim is to examine the collective mental conditions and expressions of ethnic groups, and to point out wherein they differ from other groups and from humanity at large; also, to find through what causes these peculiarities came about, the genetic laws of their appearance, and the consequences to which they have given rise.

This branch of anthropology is that which offers a positive basis for legislation, politics and education, as applied to a given ethnic group; and it is only through its careful study and application that the best results of these can be attained, and not by the indiscriminate enforcement of general prescriptions, as has hitherto been the custom of governments.

The development of humanity as a whole has arisen from the differences of its component social parts, its races, nations, tribes. Their specific peculiarities have brought about the struggles which in the main have resulted in an advance. These peculiarities, as ascertained by objective investigation, supply the only sure foundation for legislation; not *a priori* notions of the rights of man, nor abstract theories of what should constitute a perfect state, as was the fashion with the older philosophies, and still is with the modern social reformers. The aim of the anthropologist in this practical field is to ascertain in all their details, such as religions, language, social life, notions of right and wrong, etc., wherein lie the idiosyncrasies of a given group, and frame its laws accordingly.

Perhaps what I have said sufficiently explains the aims of eth-

nology. Some one has pertinently called it "the natural science of social life," because its methods are strictly those of the natural sciences, and its material is supplied by man living in society.

The final arbiter, however, to whom it appeals, is, I repeat, not the *ethnos*, not the social group, but the individual. I think it was Goethe who, nearly a century ago, uttered the pithy remark,—"Man makes genera and species; Nature makes only individuals." Hence, the justification of any result claimed by ethnology must come from the psychology of the individual; in his personal feelings and thoughts will be discovered the final and only complete explanation of the forms of sociology and the events of history. As I have elsewhere urged, man himself, the individual man, is the only final measure of his own activities, in whatever direction they are directed.[1]

On the other hand, the only rational psychology—using that term as a science of the mental processes—must be the outcome of anthropology conducted as a natural science. For thousands of years other plans have been pursued. The philosopher would delve in his "inner consciousness;" the theologian would turn to his revelation; the historian would reason on his undigested facts; but the psychologist of the future, taking nothing for granted, will define the mentality of the race by analyzing each of its lines of action back to the individual feelings which gave them rise.

It is quite likely that some who have heard me thus far, and have agreed with me, are still dissatisfied. On their lips is that question which is so often put to, and which so often puzzles, the student of the sciences, *cui bono?* What practical worth have these analyses and generalizations which have been referred to?

Fortunately, the anthropologist is not puzzled. His science, like others, has its abstract side, seemingly remote from the interests of the workaday world; but it is also and preëminently an applied science, one the practicality and immediate pertinence of which to daily affairs render it utilitarian in the highest degree.

Applied anthropology has for its aims to bring to bear on the improvement of the species, regarded on the one hand as groups,

[1] "Man himself is the only final measure of his own activities. To his own force and faculties all other tests are in the end referred. All sciences and arts, all pleasures and pursuits, are assigned their respective rank in his interest by reference to those physical powers and mental processes which are peculiarly the property of his own species." *Anthropology as a Science*, etc., p. 3.

and on the other as individuals, the results obtained by ethnography, ethnology and psychology.

Such an improvement is broadly referred to as an increased or higher civilization; and it is the avowed aim of applied anthropology accurately to ascertain what are the criteria of civilization, what individual or social elements have in the past contributed most to it, how these can be continued and strengthened, and what new forces, if any, may be called in to hasten the progress. Certainly no aims could be more immediately practical than these.

Here again anthropology sharply opposes its methods to those of the ideologists, the dogmatists, and the deductive philosophers. It refuses to ask, What *should* improve man? but asks only, What *has* improved him in the past? and it is extremely cautious in its decision as to what "improvement" really means. It certainly does not accept the definition which up to the present the philosophies and theologies have offered; any more than it accepts the means by which these claim that our present civilization has been brought about.

This department of anthropology is still in its infancy. We are only beginning to appreciate that, in the future, political economy, like history, will have to be rearranged on lines which this new science dictates. The lessons of the past, their meaning clearly apprehended, will be acknowledged as the sole guides for the future. It may be true, as De Tocqueville said of the United States, that a new world needs a new political science; but the only sure foundation for the new will be the old.

Applied anthropology clearly recognizes that the improvement of humanity depends primarily on the correct adjustment of the group to the individual; and, as in ethnology, its ultimate reference is not to the group, but to the individual. In the words of John Stuart Mill, the first to apply inductive science to social evolution, it is that the individual may become "happier, nobler, wiser," that all social systems have any value.

We may profitably recall what the same profound thinker and logician tells us have been up to the present time the prime movers in human social progress. They are: first, property and its protection; second, knowledge and the opportunity to use it; and third, coöperation, or the application of knowledge and property to the benefit of the many.

But Mill was altogether too acute an observer not to perceive

that while these momenta have proved powerful stimulants to the group, they have often reacted injuriously on the individual, developing that morbid and remorseless egotism which is so prevalent in modern civilized communities. Nor should I omit to add that the remedy which he urged and believed adequate for this dangerous symptom is one which every anthropologist and every scientist will fully endorse,—the general inculcation of the love of truth, scientific, verifiable truth.

It seems clear therefore that the teachings of anthropology, whether theoretical or practical, lead us back to the individual as the point of departure and also the goal. The state was made for him, not he for the state; any improvement in the group must start by the improvement of its individual members. This may seem a truism, but how constantly is it overlooked in the most modern legislation and schemes of social amelioration! How many even of such a learned audience as this have carefully considered in what respects the individual man has improved since the beginning of historic time. Is he taller, stronger, more beautiful? Are his senses more acute, his love purer, his memory more retentive, his will firmer, his reason stronger? Can you answer me these questions correctly? I doubt it much. Yet if you cannot, what right have you to say that there is any improvement at all?

To be sure, there is less physical suffering, less pain. War and famine and bitter cold are not the sleuth-hounds that they once were. The dungeons and flames of brutal laws and bigoted religions have mostly passed away. Life is on the average longer, its days of sickness fewer, justice is more within reach, mercy is more bountifully dispensed, the tender eye of pity is ever unscarfed.

But under what difficulties have these results been secured! What floods of tears and blood, what long wails of woe, sound down the centuries of the past, poured forth by humanity in its desperate struggle for a better life! A struggle which was blind, unconscious of its aims, unknowing of the means by which they should be obtained, groping in darkness for the track leading it knew not whither.

Ignorant of his past, ignorant of his real needs, ignorant of himself, man has blundered and stumbled up the thorny path of progress for tens of thousands of years. Mighty states, millions of individuals, have been hurled to destruction in the perilous ascent, mistaking the way, pursuing false paths, following blind guides.

Now anthropology steps in, the new Science of Man, offering the knowledge of what he has been and is, the young but wise teacher, revealing the future by the unwavering light of the past, offering itself as man's trusty mentor and friend, ready to conduct him by sure steps upward and onward to the highest summit which his nature is capable of attaining; and who dares set a limit to that?

This is the final aim of anthropology, the lofty ambition which the student of this science deliberately sets before himself. Who will point to a worthier or a nobler one?

SECTION A.

MATHEMATICS AND ASTRONOMY.

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PAPERS READ.

DEVELOPMENT OF SOME USEFUL QUATERNION EXPRESSIONS, WITH APPLICATIONS TO GEOMETRY OF THREE AND FOUR DIMENSIONS. By Prof. JAMES BYRNIE SHAW, Jacksonville, Ill.

[ABSTRACT.]

THIS is a development of the functions mentioned briefly by Hamilton (Elements, German Translation, Theil III, Kap. II, § 365. (6), XVI–XXIII) and quoted by Tait (3rd edition, chap. V, ex. 6). Various well known determinant formulæ are deduced. Then are found a set of four quaternions satisfying the equations

$$l = A.\ m\, n\, p\ m = -A.\ n\, p\, l,\ n = A.\ p\, l\, m,\ p = -A.\ l\, m\, n$$

$$S.\ l\, A\, m\, n\, p = \sqrt{-1},\ S.\ l\ m = 0 = S.\ l\, n = S.\ l\, p = S\ m\ n = S.\ m\ p = S.\ n\, p$$

and formulæ satisfied by these four quaternions are worked out.

An application is made to projective and synthetic geometry of space of three dimensions, the equations of the line, plane, point and quadric being given, with some theorems.

A second application is given, to space of four dimensions, including the equations of the line, point, plane, sphere, and quadric surfaces, with a few theorems to illustrate the use of the four quaternions developed.

THE CONSTANT OF ABERRATION. By Prof. C. L. DOOLITTLE, Bethlehem, Pa.

[ABSTRACT.]

THIS paper presents a value of this constant as deduced from 2796 Zenith Telescope observations made between the dates 1892, Oct. 10, and 1893, Dec. 27.

The number of pairs of stars employed was 106.

The original program was arranged with a view to the investigation of this constant, together with the periodic variation of the latitude. Accordingly the observations were made for the most part in the morning and evening when the effect of the aberration was large.

1744 observations were made before midnight; 1052 after midnight.

Each observation furnishes an equation of the form

$$\varphi_0 + \delta + Ay + Bx + Cz + Du + E\rho + Tu = \eta$$

φ_0 being an assumed latitude,

δ being a constant correction to φ_0,

y, x, z, u, values depending on the periodic variation of the latitude,

ρ the correction to Struve's value of the aberration constant,

u the progressive variation of the latitude.

Subtracting the corresponding terms of an equation given by a morning observation from those of an evening observation on the same pair, there resulted 1219 equations of the form

$$(A - A')\, y + (B - B')\, x + (C - C')\, z + (D - D')\, u + (E - E')\, \rho + (T - T')\, u = \varphi - \varphi'$$

E and E' having opposite algebraic signs the coëfficient of ρ was relatively large.

A solution of these equations gives for ρ the value $.107 \pm .009$, making the value of the constant of aberration as derived from this series

$$20.''552 \pm .009.$$

On the constant of nutation. By Dr. S. C. Chandler, Cambridge, Mass.

[ABSTRACT.]

This paper consists of:

(*a*) A new determination of the constant of lunar nutation from an extensive body of observations not hitherto employed for this purpose (those of Pond) and calculated by its distribution to avoid constant sources of error affecting many previous determinations.

(*b*) A combination of this value with those of previous investigations, to deduce the most probable value of this fundamental constant of Astronomy.

[Paper to be printed in the Astronomical Journal.]

Progress of the zone work at the Naval Observatory, Washington, D. C. By Assistant Astronomer A. N. Skinner, Washington, D. C.

[ABSTRACT.]

This paper details the relation of this work to the general scheme of the zone work planned by the German Astronomical Society, and states the methods employed and instruments used. In the Naval Observatory zone, —13° 50′ to—18° 10′, are more than 8689 stars. The plan is to observe each star at least twice, once in each position of the instrument. On this work 15249 observations have been made. The observations of the zone will probably be completed this coming winter, and it will require about two years after that to finish the reductions.

ON THE DISTRIBUTION AND THE SECULAR VARIATION OF TERRESTRIAL MAGNETISM, NOS. II AND III. By Dr. L. A. BAUER, Chicago, Illinois.

[ABSTRACT.]

THESE are in continuation of my researches. The special object of No. III is to show that the secondary equatorial magnetic dip-poles causing the principal phenomena of the distribution of terrestrial magnetism appear likewise, on account of their westwardly secular motion, to be the disturbing centers to which the secular variation is to be referred. Illustrated by charts and diagrams.

[Paper printed in the American Journal of Science for Sept. and Oct., '95.]

SUNSPOTS AND MAGNETIC STORMS. By Dr. M. A. VEEDER, Lyons, N. Y.

[ABSTRACT.]

IN this paper are exhibited tables illustrating methods of recording sunspots and magnetic phenomena so as to bring out their relations to each other and the periodicities involved. An attempt is made, especially, to show how the records of magnetic observations may be put in a form so as to show in a compendious way the extent of the disturbances from day to day, so that they may readily be printed and made more generally accessible. The idea is to use the length of the line traced during each twenty-four hours, instead of the distances from a base line, giving a value that will be positive and authentic for each whole day, and showing the relative amount of disturbance from day to day by single numbers instead of a multitude. Such values when arranged in tables in accordance with the twenty-seven and one quarter day periodicity, corresponding to the time of a synodic rotation of the sun, show at a glance the recurrences at this interval and afford a basis for comparison with the sunspot and aurora records, in a form that is simple and direct, and that might be printed in the journals from month to month so as to become generally known and understood. By this method the limitations surrounding a special mode of solar action, differing from the radiation of heat and light, become evident, and electro-magnetic induction of solar origin is erected into a special department of study. Thus also indications of a relation of these forces to thunderstorm action, and storm intensification generally, have been detected, suggesting a new point of view, for the discussion of meteorological problems.

ON THE SPECTRUM OF BETA LYRÆ. By Prof. EDWIN B. FROST, Dartmouth College, Hanover, N. H.

IN the present paper I propose merely to point out some of the interesting, in some respects novel, problems in stellar spectroscopy which recent studies of the spectrum of Beta Lyræ have brought to light. The obser-

vations to which reference will chiefly be made are those secured by photographic methods at Pulkowa, at Potsdam, and at South Kensington. The great series of spectral plates obtained with the objective-prism at Harvard are now under investigation, Professor Pickering having most kindly turned them over to me for that purpose. It would be premature to report at present upon the progress of that work, but it is hoped that many of the problems presented by the less extensive series of observations elsewhere may be answered in part when the studies of the Harvard plates shall be further advanced. The testimony of the objective-prism plates of Harvard is therefore excluded, except in so far as it has been given in publications by Professor Pickering.

β Lyræ is well known as a variable star, having been discovered by Goodricke in 1784. Its light varies between the magnitudes 3.4 and 4.5 in a period of $12^d\ 21^h\ 47^m$, a secondary minimum, at magnitude 4.0, occurring nearly midway between the principal minima. The brightness is the same at principal and secondary maximum, that is, full brightness. The star belongs to Vogel's spectral class Ic, which is defined as including stars "whose spectra show very faint and fine metallic lines, or none at all, and in which the hydrogen lines and D_3 are bright." β Lyræ and γ Cassiopeiæ were the type stars of this class. Although the recent observations have shown that this definition is not valid for either of these stars, as the hydrogen lines and D_3 appear simultaneously both dark and bright in β Lyræ, yet for convenience we may adhere to the classification, without committing ourselves to the implications as regards stellar evolution that may originally have attached themselves to Vogel's classification.

When the spectrum of β Lyræ was observed by Vogel at Bothkamp over twenty years ago, he announced that the intensity of the bright lines seemed to vary on different nights, and this was confirmed by other visual observations. No special progress was made in the spectroscopic study of this star until, in 1891, Pickering announced that hydrogen was also represented in the spectrum by broad dark bands and by other dark lines found in the Orion stars of class Ib, and that the bright lines appeared to shift their position to and fro across the corresponding dark lines. A connection was also discerned between the position of the bright lines and the phase of the star's variation, the bright lines falling upon the edges toward the red of the dark bands during the first half of the period, and upon the edges toward the violet during the second half. At times the bright lines also appeared double, or overlaid the dark lines in such a way that both became nearly invisible.

In 1892 Belopolsky of Pulkowa published the results of his first season's work upon this spectrum, employing the great thirty-inch refractor and a powerful spectrograph, of Vogel's design. On account of the steep color curve of the great object-glass, Belopolsky was obliged to use the visual rays for photographing, orthochromatic plates being employed. The portion of spectrum included extended from the sodium lines D, in the orange, to the hydrogen gamma ($H\gamma$) line in the deep blue. The photographs of

Vogel and of Lockyer, obtained with photographically corrected objectives, extend from a little below $H\gamma$ to the extreme ultra-violet, so that the series are complementary.

Vogel's observations were made with a small spectrograph attached to the thirteen-inch photographic refractor, but no comparison spectrum could be employed; while Lockyer's plates were obtained with a six-inch objective-prism. Belopolsky's observations alone give information as to absolute motions of the component stars in the sight-line, as his apparatus alone was fitted to permit the use of a comparison spectrum.

In the portion of spectrum covered by his plates, Belopolsky found seventy-six bright and dark lines. To these Vogel's observations added fifty-one more, while two lines occur in Lockyer's list that were not measured by Vogel. I may say the Harvard plates show practically the same lines as were seen by Vogel, except that the plates extend farther to the red than his, and thus bring out additional lines mostly, if not all, to be found on Belopolsky's list. The simplicity originally credited to the spectrum of β Lyræ is thus found to be entirely lacking.

The origin of these lines, except those due to hydrogen and helium, is still for the most part unknown. The recent discoveries concerning helium occluded in certain minerals throw, however, light upon a number of lines which were previously very puzzling. Thus the complex band at λ 4471.8, one of the most conspicuous in that part of the spectrum, is evidently to be assigned to the same source as D_3, and the strong dark line with bright edges at λ 5016 has now been reported in the spectrum of the gas or gases from clèveite. This coincides precisely in wave-length with the strong bright line near the chief nebular line, which played such a conspicuous part in the spectrum changes of Nova Aurigæ in 1892. It may be recalled that in the reappearance of the Nova as a nebula, this line was apparently replaced by the chief nebular line, which is nine tenth-meters more refrangible. It would certainly be of the highest interest to discover if any variation of temperature, pressure, or electrical conditions, of the gas giving the 5016 line could change its character and wave-length, and thus establish a connection between it and the nebular line. [It should be remarked here, however, that no bright line has yet been reported in the spectrum of β Lyræ near the position of the second nebular line at λ 4959, although a dark line falls near that point.] Besides the lines at λ 4471.8 and λ 5016, the bright line at λ 4919 is probably also to be assigned to helium, having been recently observed by Lockyer and Deslandres in the spectra of minerals containing helium.

A conspicuous group of lines is found at λ 4026–4030 in the spectrum of β Lyræ, which at present defies identification. In complexity and behavior the group strongly resembles the hydrogen lines, as was pointed out by Vogel. It was found by Young in the solar chromosphere, in 1883, and is doubtless identical with or related to the line at λ 4026, which is as characteristic of the photographic spectra of type Ib (Orion stars) as is the line at 4471.8, known as the Orion line, to which I have already alluded. It seems therefore reasonable to expect that this line will soon be

detected in the gases from minerals, and it is rather surprising that it has not already been found in the helium spectrum.[1]

The most remarkable bands or group in the spectrum of β Lyræ is that falling at the position of the first ultra-violet hydrogen line ζ, formerly designated as α_1. As many as three bright lines and three dark lines have at times been seen (*i. e.*, photographed) at this point, overlying each other or only slightly displaced upon each other. The exceptional complexity of this group is explained by the recent discovery that the upper component of ζ, at λ 3888.73, which was first detected by Hale some two years ago, in reality belongs to helium. We therefore have here a complex hydrogen group and a complex helium group falling nearly at the same point.

The problem of successfully disentangling the different components is obviously a difficult one.

The calcium lines do not play a particularly prominent part in the spectrum changes of β Lyræ.

The spectrum of this star was the first in which the D_3 line was seen as a dark line; somewhat later Keeler further announced its presence in β Orionis, but not there accompanying a bright line; a similar case is that of ε Orionis. This makes it necessary to reconsider the view held by many spectroscopists that helium possesses some individual peculiarity of radiation whereby it cannot produce a dark line, and this new fact to the contrary now removes the chief objection to Wilsing's theory to account for the fact that it appears solely as a bright line in the solar spectrum. His explanation is that the emissive power of the presumed thin sheet of helium is too low to produce an impression on the eye, so that no dark line would be seen on the body of the sun; but when the layer is edgewise, that is, on the limb of the sun, the reënforced radiation is sufficient to produce the bright line in intensity enough to be visible.

But another new problem arises—how can the dark helium line at λ 4471.8 be present in all of the Orion stars without D_3? Or, if closer examination should show that it is present as a dark line in other stars than β and ε Orionis, how can the less refrangible line be so much fainter than the other? This is but one phase of the interesting question—how can we account for the existence of a bright line in the lower part of the spectrum of an object, or substance, which gives dark lines for the same element in the upper spectrum?

Some other answer must be given than the mere denial of such a possibility, which has been the method in some quarters. Unimpeachable examples of this condition are now being plentifully found, chiefly on the Harvard plates and visually by Campbell at the Lick observatory. One of the first was γ Argus, which has a bright C, a faint or invisible F, with all the other hydrogen lines dark. Alcyone presents a similar case as

[1] Since the above was written, the line, or rather a close pair of lines, has been reported as present in the spectrum of clèveite, uraninite, bröggerite, and of helium purified to as high a degree as possible.

regards bright C. In how far this is dependent upon the conditions of emission or upon those of absorption, it is at present impossible to decide. As far as absorption is concerned, the most satisfactory explanation to me is reached from analogy with the general absorption in the sun. It is well known that the solar envelope absorbs the blue rays nearly twice as powerfully (1.7 times) as it does the red rays. In whatever proportion this is also true of *selective* absorption, for stars with powerful envelopes of hydrogen and helium, will be the contrast in the resulting dark lines in the blue as compared with those in the red.

But in β Lyræ the conditions in this respect are very puzzling, for the seven or eight ultra-violet hydrogen lines, from θ upwards to ξ, are not only dark instead of bright, but they also fail to exhibit in any degree the complexity of the lower lines $\beta, \gamma, \delta, \varepsilon$ and ζ. Accordingly the orbital motions found by Belopolsky from a study of the F line would not at all apply for the ultra-violet lines. The query arises—is there in the system a body in a comparatively quiet physical state giving a spectrum of type Ia? but, if so, how can the body or bodies hot enough to produce bright lines fail to give the ultra-violet series as bright lines, as is the case with the nebulæ? Thus the whole unsolved problem of the luminosity of gases, and of mixtures of gases and liquids, confronts us.

Another interesting point arising in this connection is how far the different intensities of the different lines due to the same element can serve as a criterion for the temperature of the body (or a stratum of the body) producing the spectrum.

The peculiar antithetical behavior of the magnesium lines at λ 4481 and λ 4352, the former of which is strong in the spark spectrum but not recognizable in the arc or flame spectra of magnesium, while the latter is strong in the arc but very feeble in the spark spectrum, led Scheiner to certain inferences regarding stellar temperatures. In spectra of type Ia, the line at λ 4481 is very strong, but fainter in type IIa, and invisible in type IIIa, while the line at λ 4352 is invisible in many spectra of type Ia, is conspicuous in the sun, and is one of the strongest lines in the spectra of type IIIa. Hence Scheiner believes we are justified in concluding that the upper layer of the atmosphere of class IIIa, that is, the so-called absorbing stratum, is approximately at the temperature of the electric arc (3000°–4000°C.); in the sun and other stars of class IIa, the temperature is higher, and reaches that of the spark from the Leyden jar (at an upper limit some 15000°C.) in stars of class Ia.

The special application in the case of β Lyræ is this: Can we obtain a knowledge of its temperature relations from the different behavior of the different hydrogen and helium lines? To establish this, extensive laboratory studies of the relative intensities of the lines of hydrogen and helium, under different conditions of temperature, pressure and electric tension, will be necessary; and such researches promise very fruitful results.

In view of the detection of the duplicity of the terrestrial helium lines by Runge, and of the solar D_3 by Hale and others, a new cause is suggested for the complexity of the helium bands in the spectrum of β Lyræ.

In a spectrum where the bands are so prominent as here, it is not at all improbable that the lower component, faint and difficult in the sun, should be conspicuous. It is evident that the discrimination must be very sharp between lines double owing to motions in the sight-line, and those by nature double, though perhaps the duplicity is far from obvious in the more familiar celestial spectra.

Another allied point upon which more information is needed, chiefly from experiments in the laboratory, is the circumstances attending the self-reversal of spectral lines. Self-reversal may be a valid cause of the duplicity and apparent displacements of lines, which might otherwise be attributed to motions in the sight-line of different component bodies. Double reversals have been for many years observed in the spectra of sun spots, where they are not to be accounted for by motions.

Allusion may be here made incidentally to the fact—which I think has received insufficient attention—that, in a particularly active spot in 1870 (and occasionally since), Young noticed the helium line to be quite conspicuous as a dark shade, near the reversed sodium lines.

In view of the uncertainties already pointed out regarding the causes of the complexity and displacements of the lines, I shall not here discuss the speculations as to the component spectra. Lockyer believes that two separate dark line spectra are present, one similar to that of Rigel, the other to that of Bellatrix, and he designates the components accordingly as R and B. I am unable to make out this distinction from his published observations, for all the lines he finds in Bellatrix' spectrum and also in the B component, are also found in Rigel, while no one of the lines in Bellatrix but not in Rigel is found in the B component.

If a real displacement exists here, the maximum relative velocity in the sight-line of the two dark line components would be about 250^{km} per second. Personally, I believe this dark line duplicity not to be real, but to be due to the presence of overlying, shifting, lines.

The displacement of the dark against the bright lines, which is very evident, would correspond to a maximum velocity of about 500^{km} per second, according to Pickering, or about one-third as much, 150^{km} per second, according to Vogel. The discrepancy is due to the difficulty in deciding what is the middle point of the overlapping lines, but both results are only incidental and provisional. The lower value will probably prove nearer the truth. A relation with the phase of variation is obvious, but I will not enter upon its discussion.

A wholly separate orbital motion is obtained by Belopolsky from his measures of the displacements of the bright lines as compared with artificial comparison spectra. On the assumption that the bright F line is not in reality double, but only appears so from the superposition of a fine dark line, Belopolsky found an immediate connection between the displacement from artificial H_β and the phase. The maximum sight-line velocity of the bright-line body varies from 68^{km} of approach to 60^{km} per second of recession, and on the assumption of a circular orbit, the distance of the bright-line body would be about $24,000,000^{km}$ (or 15,000,000 miles) from

the center of gravity of the β Lyræ system. The agreement between theory and observation is excellent, but in such difficult observations further confirmation is desirable. That eclipses are partly responsible for the variability of β Lyræ is practically proven, and at the principal minimum the body giving the continuous spectrum is eclipsed, but further than this our certain knowledge hardly extends.

NOTES ON SQUARE NUMBERS WHOSE SUM IS EITHER A SQUARE OR THE SUM OF OTHER SQUARES. By Dr. ARTEMAS MARTIN, Washington, D. C.

[ABSTRACT.]

THIS paper may be divided into a number of separate articles or propositions, as follows:

I and II. Notes and references to papers published in the Mathematical Magazine.

III. n square numbers whose sum is a square.

IV. Three square numbers, the sum of whose squares is a square.

V. Four square numbers, the sum of whose squares is a square.

VI. n square numbers, the sum of whose squares is a square.

VII. Three square numbers whose sum is equal to the sum of two other squares.

VIII. Four square numbers whose sum is equal to the sum of two other squares.

IX. Four square numbers whose sum is equal to the sum of three other squares.

X. m square numbers whose sum is equal to the sum of n other squares.

XI. $S(1^2) + S(2^2) + S(3^2) + S(4^2) + \ldots + S(n^2) = \square$, where $S(x^2) = 1^2 + 2^2 + 3^2 + 4^2 + \ldots + x^2$.

XII. Three square numbers, the sum of every two of which is a square.

XIII. Four square numbers, the sum of every three of which is a square.

[Paper to be printed in the Mathematical Magazine.]

SOME RESULTS FOR STELLAR PARALLAX FROM MERIDIAN TRANSIT OBSERVATIONS AT THE WASHBURN OBSERVATORY. By Assistant Astronomer ALBERT S. FLINT, Madison, Wisconsin.

[ABSTRACT.]

THE method of observation is that employed by Kapteyn at the Leiden Observatory, 1885-87, and consists simply in observing the differences in

the times of meridian transit between the parallax star and two comparison stars, one preceding and one following. The Repsold meridian circle is employed, and wire screens are used to reduce the apparent magnitudes of the brighter stars. A list of 76 stars, including all those known to have a proper motion of 1″ or more, has been under observation since October, 1893, and some rapid binaries and stars of the 1st and 2nd magnitudes have been added later. The results of preliminary solutions for several of the stars are presented and good agreement shown with results obtained by previous observers employing different methods.

[To be printed in full in Science.]

PERIOD OF R COMAE. By HENRY M. PARKHURST, Brooklyn, N. Y.

[ABSTRACT.]

THE observations of this star from 1831 to 1895 show that the period has changed from 361 to 365 days. If the period continues to lengthen the maxima will soon cease to be observable. However, if we adopt a sine formula, which I consider the most probable representation and which satisfies well the observations, in a few years the maxima will recede from proximity with the sun.

A CONVENIENT FORMULA FOR COMPUTING TIMES OF MOON RISING. By Prof. EDGAR FRISBY, Washington, D. C.

ON A SLIDE SCALE FOR COMPUTING PRECESSION. By Prof. EDGAR FRISBY, Washington, D. C.

CHRONOLOGY AND ANCIENT ECLIPSES. By SAMUEL W. BALCH, Yonkers, N. Y.

MAKING ASTRONOMY POPULAR. By Miss MARY PROCTOR, New York, N. Y. [To be printed in the New Science Review.]

SECTION B.

PHYSICS.

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ADDRESS

BY

W. LeCONTE STEVENS,

VICE PRESIDENT, SECTION B.

RECENT PROGRESS IN OPTICS.

INTRODUCTORY.

The reviewer who aspires to give an account of recent progress in any department of science is met at the outset by two causes for embarrassment. What beginning shall be selected for developments called recent? What developments shall be selected for discussion from the mass of investigations to which his attention has been called? So rapidly is the army of workers increasing, and so numerous are the journals in which their work is recorded, that the effort to keep up with even half of them is hopeless; or, to borrow a simile employed by the late Professor Huxley, "we are in the case of Tarpeia, who opened the gates of the Roman citadel to the Sabines, and was crushed under the weight of the reward bestowed upon her."

I have selected a single branch of physics, but one which can scarcely be treated rigorously as single. From the physical standpoint optics includes those phenomena which are presented by ether vibrations within such narrow limits of wave length as can affect the sense of sight. But these waves can scarcely be studied except in connection with those of shorter and of longer period. Whatever may be the instruments employed, the last one of the series through which information is carried to the brain is the eye. The physicist may fall into error by faulty use of his mathematics; but faulty use of the senses is a danger at least equally frequent.

Physiological optics has of late become transferred in large measure to the domain of the psychologist; but he in turn has adopted many of the instruments as well as the methods of the physicist. The two cannot afford to part company. If I feel particularly friendly to the psychologist, more so than can be accounted for by devotion to pure physics, it may be fair to plead the influence of old association. If I am known at all in the scientific world, the introduction was accomplished through the medium of physiological optics. But, with the limitations imposed, it is not possible even to do justice to all who have done good work in optics. If prominence is assigned to the work of Americans, it is not necessary to emphasize that this Association is made up of Americans; but, with full recognition of the greater spread of devotion to pure science in Europe, of the extreme utilitarian spirit that causes the value of nearly every piece of work in America to be measured in dollars, we are still able to present work that has challenged the admiration of Europe, that has brought European medals to American hands, that has been done with absolute disregard of monetary standards; work that has been recognized, even more in Europe than in America, as producing definite and important additions to the sum of human knowledge.

In drawing attention to some of this work it will be a pleasant duty to recognize also some that has been done beyond the Atlantic,—to remember that science is cosmopolitan. The starting point is necessarily arbitrary, for an investigation may last many years and yet be incomplete. To note recent progress it may be important to recall what is no longer recent.

LIGHT WAVES AS STANDARDS OF LENGTH.

You are therefore invited to recall the subject of an address to which we listened in this section at the Cleveland meeting in 1888, when Michelson presented his "Plea for Light Waves." In this he described the interferential comparer, an instrument developed from the refractometer of Jamin and Mascart, and discussed various problems which seemed capable of solution by its use. In conjunction with Morley he had already used it in an inquiry as to the relative motion of the earth and the luminiferous ether,[1] and these two physicists together worked out an elaborate series of preliminary

[1] American Journal of Science, May, 1886, p. 377.

experiments[1] with a view to the standardizing of a metric unit of length in terms of the wave length of sodium light. By use of a Rowland diffraction grating, Bell had determined the sodium wave length with an error estimated to be not in excess of one part in two hundred thousand.[2] Could this degree of accuracy be surpassed? If so, it must be not so much by increased care in measurement as by increase of delicacy in the means employed. The principle applied in the use of the interferential comparer is simple enough; the mode of application cannot be clearly indicated without a diagram, but probably all physicists have seen this diagram, for it was first brought out eight years ago.[3] By interference of beams of light, reflected and transmitted by a plate of plane parallel optical glass, and then reflected back by two mirrors appropriately placed, fringes are caught in an observing telescope. One of the mirrors is movable in front of a micrometer screw, whose motion causes these fringes to move across the telescopic field. If the light be absolutely homogeneous, the determination consists in measurement of the distance through which the movable mirror is pushed parallel to itself and the counting of the number of fringes which pass a given point in the field of view. According to the theory of interference the difference of path between the distances from one face of the plate to the two mirrors should be small; beyond a certain limit interference phenomena vanish, and this limit is smaller in proportion as the light is more complex. In the case of approximately homogeneous light there are periodic variations of distinctness in the fringes. For example, assume sodium light, which in the spectroscope is manifested as a pair of yellow lines near together. In the refractometer there are two sets of interference fringes, one due to each of the two slightly different wave lengths. When the difference of path is very small, or nearly the same for both of these radiation systems, the fringes coincide. The wave length for one is about one thousandth less than that for the other. If the difference of path is about five hundred waves, the maximum of brightness for one system falls on a minimum of brightness for the other, and the fringes become faint. They become again bright when the difference of path reaches a thousand wave lengths. The case is entirely similar to the familiar production of beats by a pair of slightly mistuned forks.

[1] American Journal of Science, Dec., 1877, p. 427.
[2] American Journal of Science, March, 1887, p. 167.
[3] American Journal of Science, Dec., 1887, p. 427.

The method of interference thus furnishes through optical beats a means of detecting radiation differences too minute for resolution by ordinary spectroscopic methods. Spectrum lines are found to be double or multiple when all other means of resolving them fail; and the difficulty of attaining truly homogeneous light is far greater than was a few years ago supposed. By the new method it becomes possible to map out the relative intensities of the components of a multiple line, their distance apart, and even the variations of intensity within what has for convenience been called a single component. Each of the two sodium lines is itself a double whose components are separated by an interval about one-hundredth of that between the long-known main components; and an interval yet less than one-fifth of this has been detected between some of the components of the green line of mercury. Indeed Michelson deems it quite possible to detect a variation of wave length corresponding to as little as one ten-thousandth of the interval between the two main sodium lines.[1]

This new-found complexity of radiation, previously thought to be approximately if not quite simple, proved to be a temporary barrier to the accomplishment of the plan of using a light wave as a standard of length. It necessitated careful study of all those chemical elements which give bright lines that had been supposed to be simple. The red line of cadmium has been found the simplest of all those yet examined. The vapor in a rarefied state is held in a vacuum tube through which the electric spark is passed, and under this condition the difference of path for the interfering beams in the refractometer may be a number of centimeters. A short intermediate standard, furnished with a mirror at each end, is now introduced into the comparer and moved by means of the micrometer screw. Its length is thus measured in terms of the cadmium wave length A series of intermediate standards of which the second is double the first, the third double the second, etc., are thus compared, and finally in this way the value of the meter is reached.

The feasibility of this ingenious method having been made apparent, Michelson was honored with an invitation from the International Bureau of Weights and Measures to carry out the measurement at the observatory near Paris with the collaboration of the director, M. Benoît. After many months of labor, results of extraordinary accuracy were attained. For the red line of cad-

[1] Astronomy and Astrophysics, Feb., 1894, p. 100.

mium at an air temperature of 15° C. and pressure of 760mm., two wholly independent determinations were made. From the first a meter was found equal to 1553162.7 wave lengths; from the second, 1553164.3 wave lengths, giving a mean of 1553163.5, the deviation of each result from the mean being very nearly one part in two millions.[1] A determination by Benoît from the first series gave 1553163.6, which differs but one-tenth of a wave length from the mean of Michelson's measurements.

The direct comparison of the lengths of two meter bars, though not easy, is a simple operation in comparison with the indirect method just described, but does not surpass it in accuracy. Every one knows that the meter is not an exact sub-multiple of the earth's circumference, and that the determination of its exact value from the seconds pendulum is full of difficulty. It may perhaps be said that the optical method is no more absolute than the pendulum method, for no human measurements can be free from error; that there is no possibility of the destruction of the original meter and all certified copies of it; and that there is no proof or probability that molecular changes are gradually producing modifications in standards of length. Even if we should grant that for all practical purposes the labor of determining the meter in terms of an unchanging optical standard has been unnecessary, the achievement is a signal scientific triumph that ranks with the brilliant work of Arago, Fresnel and Regnault. In preparation for it much new truth has been elicited, and light waves have been shown to carry possibilities of application that Fresnel never suspected.

The physicist is nearly powerless without the aid of those who possess the highest order of mechanical skill. The interferential comparer could never have been utilized for such work as Michelson has done with it, had not Brashear made its optical parts with such an approach to perfection that no error so great as one twentieth of a wave length could be found upon the reflecting surfaces.[2] In the conception, mechanical design and execution, the entire work has been distinctly American.

The interferential refractometer has been used with much skill by Hallwachs[3] for comparing the variation of refractive index of

[1] Travaux et Mémoires du Bureau Internationale des Poids et Mésures, Tome XI, 1894, p. 84.

[2] Travaux et Mémoires du Bureau Internationale des Poids et Mésures, Tome XI, p. 5, 1895.

[3] Wiedemann's Annalen, Band 47, p. 380 and Band 53, p. 1.

dilute solutions with variation of concentration. The fact of solution brings about a change of molecular constitution, affecting both the electric conductivity and the refractive index; and the changes in optical density are measurable in terms of the number of interference fringes which cross the field of view for a given variation of dilution.

LUMINESCENCE.

While all work on the visible spectrum is confessedly optical, we can no longer make an arbitrary division point and declare that one part of the spectrum belongs to the domain of optics and the other not. Since the days of Brewster and the elder Becquerel fluorescent solutions have enabled us to bring within the domain of optics many wave lengths that were previously invisible. Stokes's explanation of this, as a degradation of energy quite analogous to the radiation of heat from a surface on which sunlight is shining, has been generally accepted. But whether the phenomena of fluorescence and phosphorescence are in general physical or chemical has for the most part remained unknown or at least very uncertain. E. Wiedemann, who suggested the term luminescence to include all such phenomena, has within the present year[1] published, in conjunction with Schmidt, a part of the outcome of an extended investigation undertaken with a view to clearing up these uncertainties. He has shown that it is often possible to distinguish between cases in which the emission of light springs from physical processes and those in which it is due to chemical action, or at least invariably accompanied by this. We have here, as in photography, a transformation of radiant into chemical energy to which is super-added the retransformation of chemical into radiant energy of longer period, and this either at the same time or long after the action of the exciting rays. Indeed between this process and that of photography in colors, the analogy is quite striking. What has generally been called phosphorescence is well known to be the effect of oxidation in the case of phosphorus itself and in that of decaying wood or other organic matter which under certain conditions shines in the dark.

Wiedemann has shown that the shining of Balmain's luminous paint, and generally of the sulphides of the alkaline earths, is accompanied with chemical action. A long period of luminosity after

[1] Annalen der Physik und Chemie, April, 1895, p. 604.

the removal of the source renders highly probable the existence of what he now calls chemi-luminescence. A large number of substances, both inorganic and organic, have been examined both by direct action of light and by the action of kathode rays in a controllable vacuum tube through which sparks from a powerful electric influence machine were passed. Careful examination with appropriate reagents before and after exposure was sufficient to determine whether any chemical change had been produced. Thus the neutral chlorides of sodium and potassium. after being rendered luminous by action of kathode rays, are thereby reduced to the condition of subchloride so as to give a distinctly alkaline reaction.

Many substances moreover which manifest no luminescence at ordinary temperatures after exposure, or which do so for only a short time, become distinctly luminescent when warmed. This striking phenomenon is sufficient to warrant the use of a special name, thermo-luminescence. Among such substances may be named the well-known sulphides of the alkaline earths, the haloid salts of the alkali metals, a series of salts of the zinc and alkaline earth groups, various compounds with aluminum, and various kinds of glass. Some of these after exposure give intense colors when heated, even after the lapse of days or weeks. That the vibratory motion corresponding to the absorption of luminous energy should maintain itself for so long a time as a mere physical process is highly improbable if not unparalleled. That it should become locked in, to be subsequently evoked by warming, certainly indicates the storing of chemical energy, just as the storage battery constitutes a chemical accumulator of electrical energy. Other indications that luminescence is as much a chemical as a physical phenomenon are found in the fact that the sudden solution of certain substances is accompanied by the manifestation of light, if they have been previously subjected to luminous radiation, but not otherwise; that alteration of color is brought about by such exposure; and that friction or crushing may cause momentary shining in such bodies as sugar. There is no conclusive direct evidence thus far that such luminescence as vanishes instantly upon the withdrawal of light is accompanied by chemical action. But Becquerel demonstrated long ago with his phosphoroscope that there is a measurable duration of luminous effect when to the unaided eye the disappearance seems instantaneous.[1] Wiedemann now shows that when this duration is

[1] Becquerel, Comptes Rendus, 96-121.

considerable there is generally chemical change. Since duration is only a relative term it seems highly probable that even cases of instantaneous luminescence, commonly called fluorescence, are accompanied with chemical action on a very minute scale, and that all luminescence is therefore jointly physical and chemical in character. We have thus color evoked by the direct action of light, which disturbs the atomic equilibrium that existed before exposure, and the manifestation of such color continues only until the cessation of the chemical action thus brought into play.

The influence of very low temperature upon luminescence and photographic action has been studied by Dewar.[1] The effect of light upon a photographic plate at the temperature of liquid air, —180°C., is reduced to only a fifth of what it is at ordinary temperature; and at —200° the reduction is still greater, while all other kinds of chemical action cease. In like manner, at —80° calcium sulphide ceases to be luminescent; but, if illuminated at this low temperature and then warmed, it gives out light. At the temperature of liquid air many substances manifest luminescence which ordinarily seem almost incapable of it; such are gelatine, ivory, and even pure water. A crystal of ammonium platinocyanide, on the other hand, when immersed in liquid air and illuminated by the electric light, shines faintly when this is withdrawn. If now the liquid air be poured off so that the crystal rises rapidly in temperature, it glows brightly.

LUMINESCENCE AND PHOTOGRAPHY.

Photography, like luminescence, is a manifestation of the transformation of energy, most frequently of initial short wave length. The production of color by photography is nothing new. It was noticed by Seebeck nearly a century ago that silver chloride becomes tinted by exposure to ordinary light, with accompanying chemical change; that if then subjected a long time to red light it assumes a dull red hue, or a dull bluish hue if held in blue light. It is likewise possible by proper selection of luminescent salts to produce a selected series of tints during and after exposure to those rays which are most effective in photography. But such colors cannot be made fixed and permanent. The problem of securing on the photographic plate a faithful and lasting reproduction of the various tints of a spectrum thrown upon it has baffled most of those who

[1] Chemical News, 70, p. 252, 1894.

grappled with this subject. That it has been fully and quite satisfactorily solved cannot yet be affirmed, but the last few years have brought a far nearer approach to success than an equal number of decades previously. Viewed from the scientific standpoint the goal has certainly been touched, even if commercial demands are still made in vain.

STATIONARY LIGHT WAVES.

Two quite different methods are to be considered in tracing the recent development of this interesting application of optical principles. The first is originally due to Becquerel,[1] but lately, in the hands of Lippmann, it has been improved and brought much nearer to success than by its originator. It depends upon the production of stationary waves of light. Everyone is familiar with the formation of stationary waves upon an elastic stretched cord, and with the acoustic exhibition of stationary air waves in a closed tube by Kundt's method of light powders. That similar loops and nodes must be produced under proper conditions by interference of waves of light would appear obviously possible; and so long ago as 1868 Dr. Zenker,[2] of Berlin, explained the photographic reproduction of color, so far as it had then been accomplished, by reference to stationary light waves. But no definite proof of their production had been brought forward. A few years ago Hertz demonstrated objectively the electro-magnetic waves whose existence had been foretold by Maxwell's genius; and with suitable apparatus stationary electric waves are now almost as readily made evident as are those of sound. Hertz's brilliant success stimulated his fellow countryman, Otto Wiener, to undertake the apparently hopeless task of producing and studying stationary light waves. Wiener's admirable work[3] excited great interest on the continent of Europe, but it has been singularly neglected in England and America. It is worth much more than a passing notice.

Assume a plane silvered mirror upon which a bundle of rays of monochromatic light fall normally so as to be reflected back upon its own path. The superposition of reflected and direct waves causes a system of stationary waves, but under ordinary conditions these are wholly imperceptible. The nodes are formed upon a series of planes obviously parallel to the reflecting plane at succes-

[1] Edmond Becquerel, Am. de Chimie et de Physique (3), p. 451, 1848.
[2] Zenker's Lehrbuch der Photochromie, Berlin, 1868.
[3] O. Wiener, Wiedemann's Annalen, Band XL, 1890, p. 203.

sive distances of a half wave length. If now we consider a plane oblique to the mirror, it will cut these successive nodal planes in parallel lines, whose distance apart will be greater in proportion as the oblique plane approaches parallelism to the mirror. Although a half wave length of violet light is only $\frac{1}{5000}$ of a millimeter, it is easy to conceive of the cutting plane forming so small an angle with the mirror that the distance between the parallel nodal lines shall be a thousand times a half wave length. Such would be the case if the inclination of the cutting plane is reduced to a little less than four minutes of arc. The nodal lines would be $\frac{1}{5}$ of a millimeter apart, and readily capable of resolution if their presence can be manifested at all. Imagine a very thin transparent photographic film to be stretched along the oblique cutting plane, and developed after exposure to violet light as nearly monochromatic as possible. Then the developed negative should present a succession of parallel clear and dark lines, corresponding to nodal and antinodal bands along the oblique plane, the photographic effect being annihilated along an optical nodal line.

The realization of a photographic film thin enough for such an experiment is quite conceivable when we remember that under the hammer gold is beaten into leaves so delicate that 8000 of them would be required to make a pile one millimeter thick. By electrochemical deposit, Outerbridge[1] has made films of gold whose thickness is only $\frac{1}{100000}$ of a millimeter, or $\frac{1}{60}$ of a wave length of sodium light. Wiener obtained a perfectly transparent silver chloride film of collodion, whose thickness was about $\frac{1}{30}$ of a wave length of sodium light. This was formed on a plate of glass and inclined at a very small angle to a plane silvered mirror which served as reflector. From an electric arc lamp the light was sent through an appropriate slit and prism, so that a selected spectral band of violet fell normally on the prepared plate in the dark room. The developed negative presented the alternate bands, in perfectly regular order more than a half millimeter apart. Various tests were applied to guard against error in interpretation, and the existence of such stationary waves was proved beyond all doubt.

These waves, moreover, when polarized light was employed, furnished the means of determining the direction of vibration with relation to the plane in which the light is most copiously reflected

[1] Journal of the Franklin Institute, Vol. 103, p. 284, 1877.

when incident at the polarizing angle, and thus of subjecting to experiment the question as to whether the plane of vibration is coincident with this plane of polarization or is perpendicular to it. The former of these views was held by Neumann and MacCullagh, the latter by Fresnel. Let a beam of polarized light fall upon the mirror at an angle of about 45°. If the vibrations in the incident beam are parallel to the mirror, and hence perpendicular to the plane of polarization, those of the reflected and incident beams will be parallel to each other and hence capable of interference. But if the vibrations of the incident beam are in a plane identical with that of incidence, and hence in the plane of polarization, the vibrations of incident and reflected beams are in mutually perpendicular planes and hence cannot interfere. Wiener obtained interference fringes when the light was polarized in the plane of incidence, while that polarized in the plane perpendicular to this gave no trace of interference. The theory of Fresnel was thus confirmed experimentally. Again, the familiar phenomenon of Newton's rings shows us that on changing media there is a change of phase of the incident light, else the central spot where the two surfaces come into optical contact would be white instead of black. But there has been difference of opinion as to whether this change of phase occurs at the upper surface of the air film, where the light passes from glass to less dense air, or at the lower surface where it passes from air to more dense glass. In the latter event, there should be a node at the reflecting surface. Replacing the silvered plane surface by a lens in contact with the photographic film, Wiener obtained circular fringes with no photographic action, at the center, showing the nodal point to be at the point of contact, and thus again confirming the theory of Fresnel.

COLOR PHOTOGRAPHY.

The conditions being now specified under which stationary light waves are produced, let us imagine common instead of monochromatic light, to be transmitted normally through a transparent sensitive film. Then a variety of stationary interference planes are produced. This is the underlying principle of the process employed by Lippmann in Paris who, in 1892,[1] succeeded in obtaining a photograph of the solar spectrum in natural colors. Upon a surface backed with a reflecting mirror of mercury is a silver bromide al-

[1] Comptes Rendus, t. CXIV, p. 961, and t. CXV, p. 575.

bumen film, which has been treated with one or more aniline dyes to render it equally sensitive to waves of long and short period. After exposure and development the natural colors are manifested with brilliancy. Apart from the fundamental principle already expressed, it can scarcely be said that the rationale of the process has yet been very fully and clearly explained. Lippmann recognizes the stationary wave systems, with maxima and minima of brightness in the film and corresponding maxima and minima of silver deposit. If the incident light is homogeneous a series of equidistant parallel planes of equal photographic efficiency are produced in the film. If the plate after development is illuminated with white light, then to every point within the film there comes from below a certain amount of reflected energy which is a continuous periodic function of the distance from the reflecting surface. The total reflected light of any color becomes then represented by the integral of this periodic function for the entire thickness of the layer. The solution of this integral brings the result that the intensity of the reflected light decreases with increasing thickness of the layer, approaching zero as a limit, so long as this light is of different wave length from the homogeneous light employed for illumination of the plate. Only light of the same wave length, or of an entire multiple of this, maintains a finite value. A similar consideration applies to each of the hues composing white light. By such mathematical considerations Lippmann[1] reaches the conclusion that the light reflected from the plate must have exactly the same relations of wave length as that with which the plate was illuminated.

For the Lippmann photographs, which at first required a very long exposure, and could even than be satisfactorily viewed at only a single definite angle, it is now claimed that an exposure of only a few seconds is needed, and that the colors are visible at all angles of incidence so long as the plate is moist.[2] But like the daguerreotypes of fifty years ago they are incapable of multiplication, and great as is the scientific interest connected with them, it seems scarcely probable that they can long continue to hold an important place practically. The problem of ascertaining definitely the cause of the return of a color the same as that which falls upon a given surface may seem to be solved mathematically, but the mastery of the physical conditions required to produce a single colored nega-

[1] Journal de Physique, 1894, p. 97.

[2] Journal de Physique, 1894, p. 84.

tive, from which may be had any desired number of positives with varied hues accurately reproduced, is still in the future. From the very nature of stationary light waves it does not appear probable that the Becquerel method as improved by Lippmann will give the means of multiplying copies of a single picture. Wiener has lately published an elaborate research upon this subject,[1] in which he recognizes the necessity for the employment not of interference colors but rather of what he calls body colors (Körperfarben) due to chemical modification of the reflecting surface. M. Carey Lea[2] in 1887 obtained a rose colored form of silver photochloride which "in the violet of the spectrum assumed a pure violet color, in the blue it acquired a slate blue, in green and yellow a bleaching influence was shown, in the red it remained unchanged." But in the absence of any means of fixing these colors a promising prospect brings disappointment.

While it is abundantly possible that colored illumination upon suitable color-receptive materials can give rise to similar body colors, we are still far from having these materials under control. There seems at present to be greater promise in another and quite different application of optical principles. The suggestion appears to have been first made by Maxwell[3] in 1861 that photography in colors would be possible if sensitizing substances were discovered, each sensitive to only a single primary color. Three negatives might be obtained, one in each color; and three complementary positives from these, when superposed and carefully adjusted, would present a combination that includes all the colors of nature. In 1873 H. W. Vogel in Berlin discovered that silver bromide, by treatment with certain aniline dyes, notably eosine and cyanine blue, can be made sensitive to waves of much longer period than those hitherto effective in photography. In 1885 he proposed to sensitize plates for each of a number of successive regions in the spectrum, and to make as many complementary pigment prints as negatives, which should then be superimposed. This somewhat complicated plan proved difficult in practice. In 1888 F. E. Ives,[4] of Philadelphia, adopting the more simple Helmholtz-Maxwell modification of Young's theory of color, applied it to the preparation of suitable compound color screens which were carefully adjusted

[1] O. Wiener, Wiedemann's Annalen, June, 1895, pp. 225–281.
[2] American Journal of Science, May, 1887, p. 349.
[3] Royal Institution Lecture, May 17, 1861.
[4] Journal of the Franklin Institute, Jan., 1889.

to secure correspondence with Maxwell's intensity curves for the primary colors. The result was a good reproduction of the solar spectrum. But to reproduce the compound hues of nature it is necessary specially to recognize the fact that although the spectrum is made up of an infinite number of successive hues, the three color sensations in the eye are most powerfully excited by combinations rather than by simple spectral hues. Thus, according to Maxwell's curves, the sensation of red is excited more strongly by the orange rays than by the brightest red rays, but the green sensation is excited at the same time. This fact has to be applied in the preparation of the negatives, while images or prints from these must be made with colors that represent only the primary color sensations. Properly selected color screens must therefore be used for transmission of light to plates sensitized with suitable aniline dyes; and the adjustment of ratios with this end in view is not easy. But it has been successfully accomplished. From three negatives thus made, each in its proper tint. positives are secured; and these are projected, each through its appropriate color screen, to the same area upon a white screen. The addition of lights thus sent from the triple lantern gives the original tints with great fidelity.

Mr. Ives has devised a special form of camera by which the three elementary negatives are taken simultaneously, and also an instrument, the photochromoscope, in which a system of mirrors and lenses brings to the eye a combination similar to that projected with the triple lantern. A double instrument of this kind forms the most perfect type of stereoscope, bringing out with great vividness from the prepared stereographs the combined effect of color, form and binocular perspective. It is only within the past year that these improvements have been perfected. By further application of the same principles, Mr. Ives has produced permanent colored prints on glass, which do not require to be examined by the aid of any instrument. Each of three negatives is made with a colored screen which transmits tints complementary to those which it is desired to reproduce. The three gelatine films are soaked in aniline dyes of suitable tint and superimposed between plates of glass. When viewed as a transparency such a print gives a faithful reproduction of the natural colors.

The problem of color reproduction is thus solved, not indeed so simply, but more effectively, than by the method of interference

of light, or by those body-color methods that have thus far been applied. To the imaginative enthusiasts who are fond of repeating the once novel information that "electricity is still in its infancy" it may be a source of equal delight to believe that photography in colors, a yet more delicate infant, is soon to take the place of that photography in light and shade with which most of us have had to content ourselves thus far; but so long as an instrument is needed to help in viewing chromograms, the popular appreciation of these will be limited. We may take a lesson from the history of the stereoscope. Yet it is gratifying to recognize the great impetus that this beautiful art has received during the last few years. We may quite reasonably expect that the best is yet to come, and that it will have an important place among the future applications of optical science.

THE INFRA-RED SPECTRUM.

Among the splendid optical discoveries of this century probably the most prominent are photography and spectrum analysis, each belonging jointly to optics and chemistry. Photography was at first supposed to be concerned only with the most refrangible rays of the spectrum, but Abney and Rowland have photographed considerably below the visible red. Beyond the range thus attained qualitative knowledge was secured by Herschel, Becquerel, Draper, Melloni, Müller, Tyndall, Lamansky and Mouton. But our quantitative knowledge of this region began with the invention and use of the bolometer by Langley,[1] whose solar energy curve has been familiar to all physicists during the last dozen years. During this interval the bolometer has been used with signal success by Ångström, Rubens, Snow and Paschen, who have made improvements not only in the instrument itself but in the delicacy of its necessary accompaniment, the galvanometer. The work of Snow[2] particularly, on the infra-red spectra of the voltaic arc and of the alkalies, and that done by him in conjunction with Rubens[3] on refraction through rock salt, sylvite, and fluorite, exhibited the capacities of the bolometer even better perhaps than Langley's previous work on the sun. But more recently with the collaboration of several

[1] Langley, Selective Absorption of Solar Energy. Am. Journal of Science, March, 1883, p. 169.
[2] Physical Review, Vol. I, pp. 28 and 95.
[3] Astronomy and Astrophysics, March, 1893, p. 231.

able assistants, and more particularly the great ingenuity and mechanical skill of Wadsworth, the sensitiveness of Langley's galvanometer has been so exalted, and the bolometer connected in such manner with photographic apparatus as to make it an automatically controlled system, by which an hour's work now brings results superior in both quantity and quality to what formerly required many weeks or even months.[1] Not only is an entire solar energy curve now easily obtained in a single day, but even a succession of them. It becomes thus possible by comparison to eliminate the effect of temporary disturbing conditions, and to combine results in such a way as to represent the infra-red cold bands almost as accurately as the absorption lines of the visible spectrum are indicated by use of the diffraction grating. It will undoubtedly become possible to determine in large measure to what extent these bands are due to atmospheric absorption and which of them are produced by absorption outside of the earth's atmosphere.

With the diffraction grating, supplemented by the radiomicrometer, Percival Lewis[2] has recently investigated the infra-red spectra of sodium, lithium, thallium, strontium, calcium and silver, attaining results which accord well with the best previously attained by those who had employed the bolometer, and which demonstrate the exceeding delicacy of the radiomicrometer as an instrument of research.

THE VISIBLE SPECTRUM.

To follow out all the applications of the spectroscope that have resulted in recent additions to our knowledge would carry us far beyond the scope of a single paper. It is possible only to make brief mention of a few.

For a number of years Rowland[3] has been investigating the spectra of all the chemical elements, photographing them in connection with the normal solar spectrum, and reducing them to his table of standards, which is now accepted everywhere. The work is of such magnitude that years more must elapse before its completion. It now includes all wave lengths from 3722 to 7200, and of these the list already published extends as far as wave length 5150, or, from ultra violet nearly to the middle of the green.

[1] Langley "On Recent Researches in the Infra-red Spectrum." Report of Oxford Meeting of British Association, 1894.

[2] Astrophysical Journal, June, 1895, p. 1, and Aug., 1895, p. 106.

[3] Astrophysical Journal, Jan. to Aug., 1895.

Through the spectroscope chiefly has been established during the present year the discovery of the new atmospheric element, argon, by Lord Rayleigh and Professor Ramsay;[1] its remarkable property of green fluorescence when the electric spark is passed through it in presence of benzene, by Berthelot and Deslandres;[2] and its association in meteoric iron and various minerals with helium, now proved to be a terrestrial as well as solar element, by Ramsay,[3] Crookes, Lockyer and others.

With the diffraction spectroscope, Rydberg[4] and Kayser and Runge[5] have discovered interesting relations among the spectral lines of a large number of terrestrial elements, arranging them into series whose distribution manifests chemical relationship quite analogous to that indicated in Mendelejeff's periodic law.

By photographing the spectrum of Saturn's rings and noting the relative displacement of the different parts of a spectral line, Keeler[6] has obtained a beautiful direct proof of the meteoric constitution of these rings, a confirmation of the hypothesis put forth by Maxwell in 1859, that the outer portion of the rings must revolve more slowly than the inner portion, and yet not satisfy the conditions of fluidity. His work has been repeated and confirmed by Campbell[7] at the Lick observatory.

The spectroheliograph devised by Hale[8] has enabled him to photograph, on any bright day, not only the solar photosphere and spots but also the chromosphere and protuberances. He has made some remarkable attempts with this instrument to photograph the corona without an eclipse, unsuccessfully thus far but not without promise of future success.

POLARIZED LIGHT.

In the domain of polarized light, there have been several noteworthy recent researches. Nichols and Snow[9] have shown that calcite, though readily transparent for the brighter rays of the spectrum, rapidly diminishes in power of transmission for waves

[1] Proc. Royal Society, Jan. 31, 1895.
[2] Comptes Rendus, June 24, 1895.
[3] Nature, April 4, May 16, July 4 and July 25, 1895.
[4] Wiedemann's Annalen, 1893–1894.
[5] Wiedemann's Annalen, 1888–1895.
[6] Astrophysical Journal, May, 1895, p. 416.
[7] Astrophysical Journal, August, 1895, p. 127.
[8] Astronomy and Astrophysics, March, 1893, p. 256.
[9] Philosophical Magazine, (5), Vol. 33, p. 379.

of short period, so that for the extreme violet this power is scarcely half so great as for the yellow. The transmissive power of this crystal for the infra-red rays, between the wave length limits of 1 micron and 5.5 microns, has been investigated with the bolometer by Merritt[1] who reaches the interesting result that the transmission curve for the ordinary ray is wholly independent of that for the extraordinary, the absorption being in general much greater for the former. Several sharp absorption bands are found for each ray. For radiation whose wave length exceeds 3.2 microns, the absorption of the ordinary ray is almost complete, so that calcite behaves for such radiation just as tourmaline does for the rays of the visible spectrum. The independence of the two transmission curves is found to exist also for quartz and tourmaline, these curves for the latter crossing each other twice in the infra-red region.

The application of polarized light to the investigation of internal stress in transparent media was made more than forty years ago by Wertheim,[2] who demonstrated that the retardation of the ray is proportional to the load. An extended series of such experiments has been lately made in this country by Marston,[3] who, besides confirming Wertheim's conclusion, shows that, "for small strains at least, the colors seen in a strained glass body, when polarized light is passed through it in a direction parallel to one of the axes of strain, are measured by the algebraic difference of the intensities of those two principal strains whose directions are perpendicular to the direction of the polarized light."

A new substance with double rotatory power, like quartz, has been discovered by Wyrouboff,[4] the neutral anhydrous tartrate of rubidium, which is unique in one respect. The rotatory power of the substance in the crystalline state becomes reversed in solution. This wholly new phenomenon introduces some perplexity in connection with certain molecular theories that have been formulated to account for double rotatory power.

Crehore[5] has ingeniously applied Faraday's principle of electromagnetic rotation of the plane of polarization in carbon bisulphide to the photographing of alternate current curves. Every variation

[1] Physical Review, May-June, 1895, p. 424.
[2] Comptes Rendus, 32, p. 289, 1851.
[3] Physical Review, September, October, p. 127, 1893.
[4] Journal de Physique, (3), 3, p. 452, 1894.
[5] Transactions of the American Institute of Electrical Engineers, October, 1894, p. 591.

in the magnetic field causes variation in the amount of light transmitted through a pair of crossed Nicol prisms. The combination becomes a chronograph with an index as free from inertia as the beam reflected from a galvanometer mirror. The same instrument has been applied to measurement of the velocity of projectiles,[1] with results of exceeding interest to the student of gunnery.

PHYSIOLOGICAL OPTICS.

The temptation to dilate upon recent progress in physiological optics has to be resisted. The revision of Helmholtz's great book on this subject was interrupted by the death of the distinguished author, but the last part is now approaching completion under the care of his pupil, Arthur König, who in conjunction with Diederici has done much important work in this domain. The selection of hues for the three primary color sensations has been slightly modified. Young selected the two extremes of the spectrum, red and violet, together with green which is about midway between them. The hues now accepted by Helmholtz and those who follow his lead, including the great majority of physicists, are a highly saturated carmine red, an equally saturated ultramarine blue, and a yellowish green, corresponding somewhat to that of vegetation. The red and blue agree with those previously determined by Hering, but the rivalry between the two schools on the subject of color sensation continues, and perhaps will last through a period commensurate with the difficulty of devising crucial experiments.

Independent theories of color sensation have been brought out by Mrs. Franklin[2] in America and by Ebbinghaus[3] in Germany. The former particularly is worthy of much more extended notice than can here be given. It may perhaps be quite properly called a chemical theory of vision. Light is always bringing about chemical changes in external objects, and the eye is the one organ whose exercise requires the action of light, while such chemical action is implied in the performance of most of the bodily functions, such as the assimilation of food and the oxidation of the blood. The bleaching action of light upon the visual purple, which is continually formed on the retina, has been known ever since the discovery of this in 1877 by Kühne, who secured evanescent retinal photo-

[1] Journal of the United States Artillery, July, 1895, p. 409.

[2] Christine Ladd Franklin, "Eine neue Theorie der Lichtempfundungen," Zeitschrift für Psychologie und Physiologie der Sinnesorgane, 1892.

[3] H. Ebbinghaus, "Theorie des Farbensehens." Same Journal, 1893.

graphs in the eyes of rabbits. Mrs. Franklin considers that light sensation is the outcome of photo-chemical dissociation of two kinds of retinal molecules that she denominates gray molecules and color molecules, of which the latter arise from the gray molecules by differentiation in such a way that the atoms of the outer layer group themselves differently in three directions, and the corresponding action of light of proper wave length gives rise to the three fundamental color sensations. She develops the theory with much skill, applying it particularly to the phenomena of retinal fatigue and color blindness. To the objection that there is no direct proof of the existence of the assumed gray and color molecules it may be answered that Helmholtz himself fully recognized the uncertainty of the assumption that three different sets of nerves respond to the three fundamental color sensations, and he admitted that these may be only different activities in the same retinal cone. The supposition of three adjacent cones, responding respectively to the three fundamental sensations is made only for the sake of greater convenience in discussion.

Indeed there is still much for us to learn regarding the nature of color sensation. Among the yet unexplained phenomena are those of simultaneous color contrast. The fact that a small brightly-colored area on a gray background appears surrounded by its complementary tint is familiar enough. For its explanation it has been common to assume that there is unconscious motion of the observer's eyes, incipient retinal fatigue, an error of judgment, or fluctuation of judgment. This has been tested by A. M. Mayer,[1] who ingeniously devised methods for showing these contrast phenomena on surfaces large enough to match the colors with those of rotating color disks, and thus to arrive at quantitative statements of their hues. When viewed through a small opening in a revolving disk the subjective contrast color was unmistakably perceptible when the duration of passage of the opening was less than $\frac{1}{1000}$ of a second. The same effect was obtained in a dark room with instantaneous illumination of the colored surface by the strong spark of an electric influence machine. The duration of illumination is thus almost infinitesimal, certainly not more than $\frac{1}{10,000,000}$ of a second. The hypothesis of fluctuation of judgment is thus shown to be wholly untenable. I have performed most of these experiments, either with Professor Mayer or separately, and my testimony

[1] American Journal of Science, July, 1893.

can therefore be united with his. The case is quite analogous to that of the perception of binocular relief, which was once explained as the product of a judgment but was found to be always possible with instantaneous illumination. Professor Mayer has devised a disk photometer based on color contrast, with which the error of a single reading was found much less than with the Bunsen photometer.

The rotating color disk has been applied by O. N. Rood[1] to the determination of luminosity independently of color by taking advantage of the flickering appearance on a rotating disk upon which two parts have different reflecting powers. An extreme case of this is that of a white sector upon a black disk. At a certain critical speed the retinal shock due to momentary impression by white light becomes analyzed into the subjective impression of spectra colors, the duration of the retinal sensation varying with the wave length of the incident light. The law of this variation has been studied by Plateau,[2] Nichols,[3] and more recently with much precision by Ferry,[4] who showed that retinal persistence varies inversely as the logarithm of the luminosity. For a given source of light separated into its spectral components, the yellow is the brightest. For this hue accordingly the retinal impression is shortest and for violet it is longest.

Under appropriate conditions the after-effect on the retina has a certain pulsatory character, as first noted by C. A. Young[5] in 1872, and carefully studied within the last few years by Charpentier[6] in France and Shelford Bidwell[7] in England. A disk with properly arranged black and white sectors if brightly illuminated and looked at while revolving at a moderate rate, becomes apparently colored, just as a momentary glance at the sun causes the perception of a succession of subjective spectral hues which may last a number of seconds. The phenomenon in relation to the disk was known as early as 1838,[8] and explained by Rood[9] in 1860. The rediscovery

[1] American Journal of Science, Sept., 1833.

[2] Dissertation sur quelques propriétés des impressions produits par la lumière sur l'organe de la vue, Liège, 1829.

[3] American Journal of Science, Oct., 1884.

[4] American Journal of Science, Sept., 1892.

[5] Philosophical Magazine, Vol. 43, p. 343, 1872.

[6] "Oscillations rétiniennes," Comptes Rendus, Vol. 113, p. 147, 1891.

[7] On the Recurrent Images following Visual Impressions, Proc. Royal Society, March 27, 1894.

[8] Fechner, Poggendorff's Annalen, 1838.

[9] American Journal of Science, September, 1860.

of what has been long forgotten arouses all the interest of novelty. The " artificial spectrum top," devised by Benham[1] last autumn excited interest on two continents, and was promptly copyrighted by a prominent firm of opticians[2] in England. It would perhaps be equally enterprising to copyright the solar spectrum.

The limits of a single address forbid my touching upon the large and practically important subject of color blindness. Indeed in both physical and physiological optics much has been omitted that is abundantly worthy of attention. In behalf of my hearers it may be wise to take heed, once more, of the fate of Tarpeia, who was overwhelmed with the abundance of her reward.

[1] Nature, Nov. 29, 1894, p. 113.

[2] Nature, March 14, 1895, p. 463.

PAPERS READ.

The most general relation between electric and magnetic force and their respective displacements. By M. I. Pupin, Adjunct Professor in Mechanics, Columbia College, New York City.

[ABSTRACT.]

The author states the fundamental relations and hypotheses of Maxwell's Electromagnetic Theory. He points out the failure of the theory to explain dispersion and absorption of light and the rotation of the plane of polarization. He next points out that in all successful attempts so far to bring these phenomena within the scope of the electromagnetic theory, Maxwell's fundamental relation between electric and magnetic force and their respective displacements is abandoned, and in its place hypothetical relations are assumed, which are justified only by the circumstance that they lead to results which are in agreement with experiment. The author then shows that the relation between the electric and the magnetic force and their respective displacements which Maxwell employed in his theory is not the only permissible one.

In fact, the relation employed by Maxwell is a *statical* one, and is, therefore, a limited case of a more general one which may be called the kinetic relation, which the author obtains by considering an electromagnetic field in which the forces are varying in any continuous manner whatever.

This kinetic relation may be expressed as follows:

$$\int d\tau \int_0^t \left\{ \left(X \frac{df}{dt} - f \frac{dX}{dt} \right) + \left(Y \frac{dg}{dt} - g \frac{dY}{dt} \right) + \left(Z \frac{dh}{dt} - h \frac{dZ}{dt} \right) \right\} dt \geqq 0$$

In this formula

X, Y, Z, are the components of electric or of mag. force at any point.
f,g,h, are the components of electric or of mag. displacement at any point.
$d\tau$ is an infinitely small element of volume of the field
dt " " " " " " time

The integration should extend over the whole electromagnetic field and from the moment of starting the field up to the time t when the field becomes constant.

The author shows that this kinetic relation contains Maxwell's statical relation as a special case and that it also contains those relations between

the electric and the magnetic force and their respective displacements which were hypothetically assumed in all successful attempts to explain by the electromagnetic theory the phenomena of dispersion and absorption of light and the rotation of the plane of polarization.

FLOW OF ALTERNATING CURRENT IN AN ELECTRICAL CABLE. By M. I. PUPIN, Adjunct Professor of Mechanics, Columbia College, New York City.

[ABSTRACT.]

THE author discusses the problem in its most general aspect, showing how transmitting or receiving apparatus at any point of the cable should be taken account of by the theory. The application of Lagrange's generalized equations of motion to this problem is pointed out.

The theory of transmission of telephonic currents over long lines is then discussed as a special case and it is shown that the initial value of the current at the sending end depends on the electromagnetic constants of the transmitter and is practically independent of the electromagnetic constants of the line. The wave length and the attenuation of the waves, on the other hand, depend entirely on the electromagnetic constants of the line.

Experiments with an artificial cable are then described and the experimental results compared with the theory, showing the agreement between the two.

Several conclusions bearing on long distance transmission of power, long distance telephony, and submarine telegraphy are then discussed; the bearing of magnetic hysteresis on the attenuation of waves along cables containing iron wire is finally considered in the discussion of artificially loaded cables.

[To be printed in full in the American Journal of Science.]

ON THE COMPARISON IN BRIGHTNESS OF DIFFERENTLY COLORED LIGHTS, AND THE "FLICKER" PHOTOMETER. By FRANK P. WHITMAN, Professor of Physics, Adelbert College, Cleveland, Ohio.

[ABSTRACT.]

IN the course of a series of experiments upon color, the opportunity arose of comparing the estimation of the relative brightness of two differently colored lights by thirty-five observers. The results obtained differed in a way which could not be ascribed to errors of observation, but implied different and apparently arbitrary standards of judgment. It was

found by trial that these large differences were not due to deficient color perception.

In the search for some more accurate method of color-comparison use was made of the principle announced by Professor Rood (Amer. Jour. Sci. Vol. XLVI, Sept. 1893), that the sensation of flicker is dependent only on the difference in luminosity of two lights, and not on their difference in wave-length.

An instrument was constructed which presented to the eye for short successive periods the two colors to be compared, and allowed change in luminosity of either or both until the "flicker" sensation disappeared.

It was observed that when two colors, differing however widely, were so adjusted in brightness that the flicker disappeared, the sensation of color often disappeared also, so that it was difficult or impossible to tell what colors were under comparison. A slight variation in brightness of either color reëstablished both the sensation of flicker and that of color.

Experiments were made as follows:

1. To test the precision of setting of the instrument.

2. To see whether the measure thus obtained was a true measure of luminosity.

3. To see whether two persons with similar eyes would obtain similar results.

4. Curves were drawn, exhibiting the luminosity, as compared with a given white, of nineteen different pigments by candle light, and by the light of a cloudy sky.

The photometer was found as convenient and precise in use as most ordinary photometers; was found to give a measure of luminosity comparable with that obtained by widely different methods; and to give like results in the hands of different observers provided the eyes were in fairly normal condition.

[This paper will be printed in full in the Physical Review.]

Observations on the relations of certain properties of line spectra to the physical conditions under which they are produced.

A preliminary paper on work in progress in the Physical Laboratory of the Johns Hopkins University. By J. F. Mohler and W. J. Humphreys, Johns Hopkins University, Baltimore, Md.

[ABSTRACT.]

The properties of line spectra investigated were the width and character of the lines and their wave frequency. The conditions studied were the amount of material in the arc used to produce the light, the strength of the current, and the pressure to which the arc was subjected.

A large amount of material in the arc broadens the lines and often reverses them. A heavy current has a similar effect, and in both cases the

broadening is often unsymmetrical, being more to the red than to the violet.

Pressure usually broadens the lines and sometimes reverses them. In almost all cases there is a shift of the line toward the red, proportional to pressure. The lines of the carbon bands show no shift, but all the other lines do. Of all the other lines observed Yt shows the least displacement and Cd. the most, being in the case of the latter .09 Angstrom unit for ten and three-quarters atmospheres pressure for the green line at wave length 5085. Under pressure the spectrum approaches in appearance that of the sun.

ON STANDARD COLORS. By Prof. J. H. PILLSBURY, Stoneham, Mass.

[ABSTRACT.]

THE necessity of some recognized standards of color is felt in all departments of life, but nowhere is the need more emphatic than in the work of the educator and the artisan. The outrageous work shown in the so-called decorations of our homes and churches abundantly emphasizes the need of a new generation of artisans. This requires the education of the rising generation in correct principles of color. In order that this may be possible we must have some generally recognized standards of color and color terms. These considerations led me in 1880 to propose the use of such a set of color standards in educational work and the proposition was received with great favor from the first. The standards proposed were definite areas of the normal solar spectrum selected with great care, consideration being made of these related factors.

1. The need of a practical scheme of standards.
2. The use of those terms already familiar.
3. The selection of the particular areas which represent the three primary sensations of color.

With these considerations in view I selected the following as the proposed "spectrum standards," viz.: (measurements of wave-lengths given in microns) RED .6587, ORANGE .6085, YELLOW .5793, GREEN .4156, BLUE 4695, VIOLET .4210.

With these as standards I have been able to accomplish these results:

1. Combining any two adjacent standards will give every intermediate hue of the spectrum.
2. Combining two adjacent standards with white and black by means of Maxwell discs has thus far reproduced every color either of art or nature with which I have experimented except the purples all of which are similarly produced by the combination of red and violet.
3. The combination of these six standards produces a perfectly neutral gray.

These results I have not been able to obtain by using a red with a shorter wave-length, such for example as that of vermilion.

The Standard Dictionary has adopted the plan proposed by me but with a slight variation of the wave-lengths of the standards. The red there proposed is a distinctly orange red. The blue is practically my violet and the other colors almost identical with those proposed by me.

It seems to me very desirable that a commission be constituted by some learned society to determine upon a series of color standards that may be made the basis of all future color work.

See *Science* for Feb. 26, 1892, June 9, 1893 and *Nature* for Aug. 22, 1895.

On the significance of color terms. By Prof. J. H. Pillsbury, Stoneham, Mass.

Expansion of Jessop's steel, measured by interferential method. By Prof. Edward W. Morley, Cleveland, Ohio, and Prof. William A. Rogers, Waterville, Me.

[To appear in full in the Physical Review.]

A new determination of the relative lengths of the yard and the meter. By Prof William A Rogers, Waterville, Me.

The effect of age upon the molecular structure of iron, glass and steel. By Prof. Wm. A. Rogers, Waterville, Me.

An examination of the statement by Maxwell that all heat is of the same kind. By Prof. William A. Rogers, Waterville, Me.

Voice analysis with photographic record. By Dr. F. S. Muckey and Dr. William Hallock, Columbia College, New York, N. Y.

Voice production, with photographs of the vocal cords in action. By Dr. F. S. Muckey and Dr. William H. Hallock, Columbia College, New York, N. Y.

Color definitions for the Standard Dictionary. By Prof. William Hallock and Mr. R. Gordon, Columbia College, New York, N. Y.

ILLUSTRATION OF GEMS, SEALS, ETC. By Prof. WILLIAM HALLOCK, Columbia College, New York, N. Y.

A PHOTOGRAPHIC METHOD OF COMPARING THE PITCH OF TUNING FORKS. By Prof. WILLIAM HALLOCK, Columbia College, New York, N. Y.

ELECTROLYTIC REPRODUCTION OF RESONATORS. By Prof. WILLIAM HALLOCK, Columbia College, New York, N. Y.

A NEW APPARATUS FOR STUDYING COLOR PHENOMENA. By ERNEST R. VON NARDROFF, Instructor of Physics, Barnard College, New York, N. Y.

NOTE ON THE LIMITS OF RANGE OF THE HUMAN VOICE. By Prof. W. LE CONTE STEVENS, Troy, N. Y.

[This paper will appear in the Physical Review.]

THE REPRODUCTION OF COLORS BY PHOTOGRAPHY. By FREDERIC EUGENE IVES, Philadelphia, Pa.

ON A NEW FORMULATION OF THE SECOND LAW OF THERMODYNAMICS. By L. A. BAUER, Ph.D., University of Chicago, Ill.

AN EXPERIMENTAL INVESTIGATION OF THE ROTARY FIELD. By Prof. HENRY S. CARHART, Professor of Physics, Univ. of Mich., Ann Arbor, Mich.

[This paper will be printed in The Electrical Journal, Chicago.]

PHENOMENA WITH ELECTRIC WAVES ANALOGOUS TO THOSE OF LIGHT WITH A DIFFRACTION GRATING. By C. D. CHILD, Instructor in Physics, Cornell Univ., Ithaca, N. Y.

[To be printed in the Physical Review.]

THE METHOD OF RECIPROCAL POINTS IN THE GRAPHICAL TREATMENT OF ALTERNATING CURRENTS. By Dr. FREDERICK BEDELL, Ithaca, N. Y.

CALIFORNIA ELECTRICAL STORMS. By JOHN D. PARKER, Post Chaplain, U. S. Army, San Diego, California.

[This paper will be printed in The American Meteorological Journal.]

RELATIONS OF THE WEATHER BUREAU TO THE SCIENCE AND INDUSTRY OF THE COUNTRY. By Prof. WILLIS L. MOORE, Chief of U. S. Weather Bureau, Washington, D. C.

SOLAR MAGNETIC RADIATION AND WEATHER FORECASTS. By Prof. FRANK H. BIGELOW, U. S. Weather Bureau, Washington, D. C.

CLOUDS AND THEIR NOMENCLATURE. By Prof. CLEVELAND ABBE, U. S. Weather Bureau, Washington, D. C.

ON CLOUD PHOTOGRAPHY. By ALFRED J. HENRY, U. S. Weather Bureau, Washington, D. C.

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ADDRESS

BY

WILLIAM McMURTRIE, PH. D.,

VICE PRESIDENT, SECTION C.

THE RELATIONS OF THE INDUSTRIES TO THE ADVANCEMENT OF CHEMICAL SCIENCE.

WE justly congratulate ourselves that development and progress in chemistry, both in science and technology, have been more rapid in the past three decades than ever before, and that as much has been accomplished in this period as in all the years preceding since reactions have been known and applied. New elements, new compounds, new theories and new laws have followed each other in the manifold directions with such enormous rapidity that few have been able to keep informed of all, and most of us of only a few, of the discoveries and generalizations that have been made. It is for the purpose of exchanging information on these subjects that we come together at the present time, and it has been the custom of the Chairman to discuss one or another of these lines of progress, setting forth the most important of what has been developed in the more recent times. In many of the discussions and addresses on similar occasions by those more or less closely allied with or engaged in the study of so-called pure chemistry, much has been said of the practical value of the results obtained in the scientific laboratories devoted to research, and the uses they have found in daily life. No one has arisen to question the truth of what has been said, nor could it be questioned, for those men who have been working with the most unselfish devotion to the pursuit of truth for truth's sake, and with little hope of reward for the service they have rendered, have acquired and disseminated a store

of knowledge which has added so largely to the capacity of all men for work that only the most grateful acknowledgments may be offered. While all this must be accepted, it is seldom that anything is heard regarding the reciprocal influence of the industries and the ordinary occupations of daily life, upon the development or advancement of chemical science, and it has seemed that, in this period of relaxation, it would be well to stop and consider what are the relations of the industries to the science from the other side of the question, and what aid has come from the former to the latter to promote its advancement, if, indeed, any distinction can be made so far as the additions to human knowledge are concerned. For science is cosmopolitan, as it were, and omnivorous, and facts from whatever source, and of whatever kind, are greedily absorbed to form a part of the grand structure of human knowledge, whether they come from efforts made at leisure and in the quiet of the study or private laboratory, or whether they are developed in the struggle for existence and the daily bread.

In its earlier development, substantially beginning with the present century, chemistry was the newest of the physical sciences. It grew up out of the empiricism of the preceding centuries and had its foundation in the facts to be found in the daily practice of those engaged in the endeavor to meet the demands of the current needs. As civilization progresses, culture extends, demands consequently grow, and it is one of the inevitable laws of sociology and political economy, as of nature, that these demands shall be met. To meet them human ingenuity must be taxed for the determination of methods and means; and whether it be to secure immediately useful results or to establish more abstract truths, intellectual endeavor is required, knowledge must be increased, and science therefore advanced. Literature is filled with description of the service which the science of chemistry has rendered to the industries and the commercial world, and the development of the tar color industry is the favorite example of this so frequently cited. History, so far as it is written, for the most part deals with the subject from this standpoint. But it may properly be questioned whether the industry was wholly the outcome of scientific research or whether science received much, at least, of its inspiration, its suggestion, its original material from the industry already developed in an intensely empirical way. It is this side of the question that will occupy us at the present time and we shall en-

deavor to call attention to some of the influences which operate from one side or the other to bring about the results indicated, and to the reciprocal influences which flow from the results themselves.

The true fundamental principles of the science were not developed and set forth through the classic researches and deductions of the great leaders, Dalton, Priestley, Cavendish, Black, Wenzel, Richter, Lavoisier, Gay Lussac, Avogadro, Dulong and Petit until the close of the last and the earlier years of the present century. But even before the beginning of the last century the rapid progress of civilization and culture in other lines had made demands for the products of the chemical arts and they were met in ways that were empirical, it is true, but by reactions which were as positive then as they are now, even though they were unknown; and they furnished fertile food for study and speculation on the part of the philosophers in fields quite new to them, led them out from the libraries of the monasteries to the active work of the busy world, furnished them with facts for collaboration and classification, from which they were amply able to construct the hypotheses and build up the theories which have been of so much value to the civilized world. During the entire century the industries thrived and grew, met the demands put upon them and brought about the establishment of facts that long since were recorded as new discoveries.

The acknowledged fathers of the science of chemistry, although eminent scholars and connected with the institutions of learning, were many, if not most of them, directly interested in the manufacture of chemical products, and by their general education and higher intelligence were enabled to contribute to their material advancement. At the period in which these men lived and worked, these industries could with difficulty meet the demands of the advancing civilization, and that they were profitable then, even as they were later, we may learn from the experience and writings of Chaptal,[1] who was turned from the profession of teaching to establish at Montpellier, as he tells us, large works for the manufacture of sulphuric, nitric, muriatic and oxalic acids, alum, copperas, sal ammoniac, sal saturn, white lead and the preparations of lead, mercury, etc. He declares that he had made "mountains of alum without being able to crystallize it," until he had, through the analysis of Roman alum, determined the presence of potash in the crystallized product. And in order that he might

[1] La Vie et l'Oeuvre de Chaptal, p. 31.

have proper apparatus for his works he undertook the manufacture of the porcelain and pottery he required. A little later he became interested in dyeing and calico printing in a commercial way. How profitable this manufacture was may be gathered from the fact that after the political reverses which brought about his deposition from the public life in Paris which had consumed his entire fortune, he returned to his manufacture at Montpellier and in a single year realized from it a handsome net profit of 350,000 francs. He further relates that, encouraged by his success, other chemists of France established large manufacturing works and entered into their management. He was closely associated with Lavoisier, Berthollet,[2] Monge, Fourcroy, Carny, Vandermonde, Guyton de Morveau and others in the manufacture of gunpowder near Paris, and his memoirs show that during his residence at Montpellier he was in constant correspondence with the chemists of Paris and elsewhere. Dubrunfaut[1] states that at the instigation of the Comptroller General Turgot, the Academy of Sciences of Paris offered a prize in 1776 for the invention of a method for the production of niter and that Stahl and Lavoisier did not disdain to take an interest in the subject of the prize. It amounted to £3000 and was awarded to Thouvenel who was required, we are told, to justify experimentally the theory of Lavoisier. At that time Lavoisier was director of the Royal Saltpeter Works. Berthollet was interested in bleaching and dyeing, suggested the use of chlorine for the former and in 1791 published a work entitled Elements of the Art of Dyeing. Guyton de Morveau[2] was devoted to analytical and technical chemistry, and among other things he founded saltpeter works in 1773 and soda works in 1783.

Much of the work, therefore, not only of Chaptal but of other chemists of his time, was doubtless done in response to demands made upon them by the exigencies of the manufactures, but how many of the results they communicated to the journals and learned societies flowed directly therefrom we are not told. Certainly they could not have failed to study closely the phenomena thus offered for their observation and which in many respects could not have been as efficiently exhibited in any other way.

So also, as we are told by Meyer[3] and other historians, the earlier

[1] Le Sucre. II. 95. Note.
[2] Schaedler, Handwörterbuch der Wissenschaftlich bedeutenden Chemiker.
[3] Geschichte der Chemie. Zweite Auflage 1895.

contributors to the new science, Boyle, Kunkel, Bergmann, Scheele, Margraff, Macquer, Duhamel and others, were largely devoted to the development of certain chemical processes in the industries. With all these men, the other great leaders of the science were closely associated; the problems constantly arising and the results obtained in their solution were doubtless subjects of frequent discussion and led them to profitable study, regarding them and the fundamental and natural laws upon which they were based. And what was true of that earlier period of the history is true to-day and to an increasing degree must find illustration in future work. The industries are still pushing forward with earnest competition to supply the demands which grow with the years, and the hard questions which come from managers and proprietors to professional men are as numerous and as difficult in their way as those which puzzled the early philosophers, and stimulate an earnestness in endeavor and investigation that brings the highest and most useful results. We must admit that without these hard questions the advances in the science itself would be less rapid and the intellectual activities of investigators less alert.

Beautiful illustrations of the results growing out of such demands are everywhere to be seen at the present day even as they were in former years, although they are not often to be found recorded in the pages of published history. Many of us will remember the incident cited by Hoffmann[1] in his necrological notice of Dumas describing the circumstances which led to the discovery of the absorption of chlorine by organic bodies, in which he declares that "it is not generally known that the theory of substitution owes its source to a soirée in the Tuileries." Dumas had been called upon by his father-in-law, Alexander Brogniart, who was director of the Sevres Porcelain Works, and as Hoffmann says, in a measure a member of the royal household, to examine into the cause of the irritating vapors from candles burned in the ballroom, a demand to which Dumas readily acceded, because he had already done some work upon the examination of wax which could not be bleached and was therefore unmerchantable. He was readily led to the conclusion that the candles used in the palace had been made with wax which had been bleached with chlorine and that the vapors were hydrochloric acid generated in the burning of the candles. But examination of the wax of the candles showed that the quantity

[1] Berichte der Deutschen Chemischen Gesellschaft, 17. R. 667.

of chlorine found was greater than could be accounted for by its presence as a mechanical impurity, and from it Dumas was led to experiments which showed that many organic substances when heated with chlorine have the power to fix it, and from these results he was in turn led to the further generalization concerning the law of substitution. In this connection Hoffmann says, "This information upon the origin of substitution, which the author of this sketch had from the mouth of Dumas himself, is more than an interesting incident. We frequently see that like the Luxembourg palace, the Tuileries, besides their historical legends, have likewise scientific memories. How wonderful! A ray of sunlight reflected from the window of Luxembourg and accidentally seen by Malus through a plate of calcspar, revealed to him the phenomenon of double refraction, adding a new province to the domain of physics; while the acid vapors from a smoking; burning candle in the ballroom of the Tuileries led Dumas to study the influence of chlorine upon organic bodies and finally led him to speculation upon this action which for many years had controlled the science and even to-day has a mighty influence upon its development."

It would be difficult to follow Dumas through the hundreds of investigations he made in all the fields of chemical activity, clearing up the questions arising in the various occupations of daily life and in all its departments, even as it would that of other men active in progressive work. Much of the work of Dumas, as shown by Hoffmann and the published records, was devoted to the solution of such questions, and much of his inspiration was drawn from them. It was an incident similar to that already described, that brought Dumas to the reaction whereby hydrogen sulphide may be oxidized to sulphuric acid. He found the walls of one of the bath rooms at Aix les Bains covered with crystals of calcium sulphate which could have no other source than the vapors liberated from the hot water. No trace of sulphuric acid could be found in the atmosphere of the room. The portières of the room soon acquired an acid reaction which proved to be due to sulphuric acid. Dumas concluded that the combination of hydrogen sulphide with oxygen had occurred upon the wall itself, the porous surface exercising an influence similar to that of platinum black upon hydrogen and oxygen. And subsequent investigation showed that when air, steam and hydrogen sulphide are passed over porous substances at from 40° to 50° C. and still better at 80° to 90°, sulphuric acid is

quickly formed without intermediate formation of sulphurous acid or separation of sulphur.

Similar instances are set forth by Hoffmann,[1]—who seems to have recognized the value of the influences we here have in mind — in his necrological address upon Liebig, whose well-known devotion to the industries and their advancement is so familiar and interesting. Hoffmann says "no branch of chemical industry has failed either directly or indirectly to receive benefit from Liebig's works." He calls attention to the study of the fat and acetic acid industries and declares that the key to their peculiar operations is of his making, that the preparation of the prussiates and fulminates, the manufacture of the cyanides, the production of the silver mirror, were the result of Liebig's work. His interest in the problems of agriculture and of the nutrition of plants and animals, of physiology and pathology, led him not only to the development of many new industries, but to the establishment of many of the truths of science as well. His method for the production of artificial foods and concentrated animal extracts were not the smallest of his contributions to the industry, and the possibilities of their value and wide application in turn led to further investigation. Meyer,[2] quoting from Hoffmann, says, "if we could hold up to view all that Liebig has done for the well being of the human race in the industries, in agriculture or in the promotion of health, one can scarcely declare that any other scholar of his time has left a richer legacy to mankind."

And what Hoffmann has said of Liebig is also applicable to himself, for in many respects he rivalled Liebig in his intelligent comprehension of commercial and industrial needs and their value in suggesting new and fruitful lines of work. No question could be proposed to him that had not for him some germs of useful thought and it was the utilization of such possibilities as came to him in this way that made him great. His genius for this will be illustrated in connection with the incidents in the coal tar color industry which show the relation of that great branch of human endeavor to the subject in hand.

It seems to make little difference to which branch of chemical work we turn for illustrations of the ideas just presented. The enormous losses suffered by Italy and France by the diseases of the

[1] Hoffmann. Berichte der Deutschen Chemischen Gesellschaft, VI, 467.
[2] Geschichte der Chemie, 281.

silk worm, the deterioration of the wines and the diseases of farm animals, made demands upon the genius of Pasteur, and through his brilliant work and magnificent results attention has been directed to the field of bacteriology and fermentation, and almost a new science has been built upon it. What a mass of material has through this one branch of work been added to the sum of human knowledge and what an impetus has it given to the advancement of science! The industries demanded relief from their losses, but the path to that relief is strewn with facts which have been utilized for the establishment of new principles; and the new principles, extended to the other industries, have widened still further the field and led to the study of the products developed in the growth and nutrition of the lower organisms, with results, the spread of whose influence it would be difficult to define.

Some of us will remember that a little more than a decade ago, many of the leading chemists of this country were called upon to settle a commercial dispute in Chicago, turning upon the question of an admixture of fats in the adulteration of lards and that, on account of the lack of knowledge then prevailing regarding the exact constitution and reactions of various fats, it was impossible to arrive at satisfactory conclusions with regard to the mixtures submitted. It was embarrassing for chemists to admit the weakness, but it nevertheless had useful results. Since that time the development of knowledge concerning these products has been such that it is possible readily to determine in many cases, not only the components of such admixtures but even the quantity of each component present.

Such illustrations in increasing numbers will occur to every one who may consider the history of the science and the industries from this point of view. The coal tar color industry, which has so frequently been cited and described as the direct outcome of scientific investigation, will serve admirably to illustrate further the relations we are considering. No one of the industries has been so rapid in growth or has attracted the same degree of attention from both scientists and technologists, or has had so wide an influence upon the progress of the other industries and scientific work. A brief review of the conditions of its development from the standpoint of this discussion will be of interest and will serve to show how much the purely scientific side of chemistry may be found to owe to the development of the technical side.

The origin of the crude product of this industry, the manufacture of gas, is comparatively modern. Though it was known in the latter part of the last century it did not find extensive application permanently until between 1830 and 1835. But from the time of its first extended application, its by-product, tar, became a troublesome nuisance and many endeavors were made on all sides to find some means for its disposition and utilization. It was consumed by burning, it was boiled down in open vessels and its residues used as preservative paint for wood and metals; its lighter and more volatile products were subsequently collected by condensation and put upon the market as a solvent for fats, waxes, rubber, etc., and was so used in the manufacture of varnishes. According to Lunge,[1] Accum was the first to boil tar down in close vessels and thus obtain volatile oil which could be used as a cheap substitute for turpentine. Dr. Longstaff declares that, in conjunction with Dr. Dalton, he erected the first distillery for coal tar in 1822 near Leith, and that the spirits obtained were sent to Mr. Mackintosh, while the residue was used for making lampblack. Roscoe states that the distillation was carried on near Manchester in 1834, the naphtha obtained being used for making black varnish with the pitch. So that the lighter distillates had been furnished to the markets some years before Mansfield began, in 1847, the distillation of the lighter oils to obtain products which might be used for lighting purposes. It was in the course of this work that he determined the composition of the lighter oils in the market and found that they contained considerable quantity of benzene, a fact discovered by Hoffmann two years before. Supplies for the subsequent uses in the color industry were therefore possible.

It may be observed here that the discovery of this compound by the dry distillation of coal, *de novo*, in the laboratory, would have been practically impossible[2] since, according to Perkin,[3] 100 lbs. of coal yields only 0.85 oz. of coal tar naphtha, and 0.275 oz. of benzene. The operations of the industry carried out on a large scale are necessary to this,[4] and such operations we know and shall see have furnished to those working in purely scientific lines materials for study which has given the most important results and without which many of the relations would still be unknown.

[1] Lunge. Coal Tar and Ammonia, 189.
[2] Compare Roscoe and Schorlemmer, Treatise on Chemistry, III. pt. III, 51.
[3] Jour. Soc. Arts, 1869, 101.
[4] Compare Hoffmann. Jour. Soc. Arts, 1863, 647.

But to proceed. With the commercial production of benzene, its derivative nitrobenzene was readily obtained in large quantities. It had been made, it is true, years before by Mitscherlich in 1834, from benzene of benzoic acid, and by Laurent a little later by the action of nitric acid upon light oil of tar. Collas, a French pharmacist, made it in 1848 in a large way in Paris, and later Mansfield took up its manufacture from the product of his stills, putting it on the market as artificial oil of bitter almonds, or oil of Mirbane, to be used in scenting soap.

So aniline which Unverdorben produced in 1826 by dry distillation of indigo and called krystallin, and Runge first separated from coal tar by treating it with hydrochloric acid in 1834 and called blauöl, and Fritsche produced by digestion of indigo with potash and distillation of the product in 1840 and called anilin, and Zinin produced in 1842 by reduction of nitrobenzene with ammonium sulphide and called benzidam, remained a scientific curiosity, the true constitution of which was not fully determined until some years after it had been produced by Bechamp by reduction of coal tar nitrobenzene with iron and acetic acid and Perkin had utilized it in the manufacture of mauve.

And so the way for Perkin had been prepared. Both the industry and the science, so far as they had been able, had done their share: the industry, by efforts at the utilization of the products at hand and showing possible commercial profit; the science, in the struggle after new compounds. The spirit of the iatrochemists still prevailed and substantial benefits flowed from it as of old. Perkin[1] in an effort to produce a compound valuable and scarce in the market and to effect the synthesis of quinine, produced aniline purple or mauve instead. Starting out, as he says, with the consideration of the empirical formula he concluded that by the oxidation of allyl-toluidine he might attain his end. Describing his experiment he says: "For this purpose I mixed the neutral sulphate of allyl-toluidine with bichromate of potassium, but instead of quinine I obtained only a reddish brown precipitate. Nevertheless being anxious to know more about this curious reaction, I proceeded to examine a more simple body under similar circumstances. For this purpose, I treated the sulphate of aniline with bichromate of potassium. The mixture produced nothing but an unpromising black precipitate; but, on investigating this precipi-

[1] Chemical News, 1861. 347.

tate, I found it to be the substance which is now, I may say, a commercial necessity." Perkin treated the black precipitate with different solvents in the study of its properties and found it to yield to alcohol a colored solution. With more of the inventive and commercial spirit than prevailed with his illustrious teacher in whose laboratory he was working, he at once began experiments to determine whether this new color, so beautiful in its hues, could be fixed upon textile fibers, and succeeded in dyeing a strand of silk with it without the aid of any mordant whatsoever. He promptly submitted his discovery to Puller of Perth who tried the color in a larger way, proving its commercial value. The patents were secured and Perkin at once devoted himself to the industrial production of the color and, after more or less difficulty, always incident to the manufacture of a new substance, he attained commercial success. The tar color industry was launched; it was immensely profitable; it furnished incentive to further investigation and experiment in similar lines, a new field was opened up, and what a flood of results has come from it. In them both empiricism and rationalism have been represented, and the addition to the number of new substances, whose properties and constitution have been essential to the establishment of new theories and new laws has been enormous, and unprecedented in all the history of chemical work. The search after the production of a commercial product yielded, accidentally as it were, and almost empirically, the seed from which this great and flourishing tree has sprung.

For it must not be forgotten that after Perkin had obtained his oxidation product of aniline and had found that some portion of it was colored and could be applied to the dyeing of fabrics, his study of its properties ended for the time being and it was not until 1863 that he was able to take up this subject and follow it to conclusion, establishing the constitution of the new compound.

The history of the coal tar color industry is full of examples of the production of new substances and new reactions by the industry of the highest importance to the advancement of knowledge in the domain of chemistry and to the development of the great theories to which, in turn, much of progress both in science and technology has been due. In this connection one may study, with profit and interest, the very able address of H. Caro[1] before the Berlin Chemical Society, on the subject of the "Development of

[1] Berichte der Deutschen Chemischen Gesellschaft, 25. R. 955.

the Coal Tar Color Industry." While very properly giving the fullest credit for the scientific or rational work done in this connection and the applications of it in the industries, he shows many examples of the important results attained by technical or empirical methods and of the highest interest and value to the science. He calls attention to the fact that C. E. Nicholson suggested to Hoffmann that pure aniline would not yield aniline red, and that it was not the true agent for the production of this compound. A gallon of aniline with a constant boiling point of 220° C. sent to Hoffmann by Nicholson gave such a result; while a sample of the ordinary aniline of commerce, and boiling at from 182° to 220° yielded an abundant quantity of color. From this Hoffmann concluded that the commercial aniline contained a second base which, together with aniline and homologous with it, entered into the reaction to produce the regular result. But Hoffmann[1] declared that, if such an admixture of bases existed, their separation by any other than operations on a large scale would be out of the question, a condition found by other investigators. Nicholson had already suggested the presence of toluidine in the mixture. Hoffmann tried making the color with pure toluidine from tolu balsam sent him by Muspratt and found that this too gave a negative result. But upon mixing the pure aniline from Nicholson in proper proportions with the pure toluidine from Muspratt, the proportions corresponding with one molecule of benzene to two molecules of toluene the red color was promptly produced. In this connection Hoffmann said the "industry was ahead of the science" and Caro said "hence the industry was not only the generator of aniline red, but furthermore it had opened up the way to the rational utilization of benzene and its homologues for all present and future uses of color manufacture."

Artificial alizarine has much the same kind of history. It was developed by Graebe and Liebermann by most rational methods and from the constitution and reactions of the body itself. Starting with a commercial body, produced by industrial methods and in most empirical ways, they endeavored to reproduce it by rational synthesis and succeeded. Their method through dibromanthraquinone was not, however, a commercial possibility and it remained for Perkin, with his industrial experience and capacity, and his engineering skill combined with his knowledge of chemistry, to over-

[1] Berichte der Deutschen Chemischen Gesellschaft, 25, 976.

come the manufacturing difficulties and to attain this end by other means and reactions than had been proposed by Graebe and Liebermann. The process proposed by the latter was precluded by the high cost of bromine and Perkin replaced it by sulphuric acid, producing the anthraquinone sulphonic acids which yielded after the melt the product desired. The industrial genius of Perkin[1] gave artificial alizarine and with it a long series of products and problems for study and solution by chemists everywhere. It taught reactions that were fertile in stimulating new research and established facts that could not be, or at least were not, discovered in the laboratory. For instance in the course of the manufacture, Perkin found that when, as sometimes happened, sulphonation of the anthraquinone was not thoroughly effected through insufficient heating or use of too little acid, a really better product was obtained than when the process had proceeded normally. He found that in the latter case the color of the resulting product was less brilliant than when these irregular conditions prevailed; that, in the latter, the resulting paste was a mixture of colors, while with the former, nearly pure alizarine was the result. Investigation confirmed the outcome of the practice and showed that from the anthraquinone monosulphonic acid, only pure alizarine was produced, while from the result of higher sulphonation a mixture of products was secured. Such a discovery may have been possible only in the larger way occurring in the works and might have long been overlooked in the laboratory. At any rate it was brought out in the industrial operation of the reaction, and a new fact was added to the sum of knowledge.

This discovery brought further necessity and new invention. By the ordinary method of sulphonating then enployed, the monosulphonic acid could not readily be produced and it remained for Perkin to advance both science and technology still further by the determination of a new process for attaining this end. He found[2] that dichloranthracene which is easily made may be as easily sulphonated and that the dichloranthracene sulphonic acid is readily converted to the anthraquinone sulphonic acid by heating with sulphuric acid, the final result depending upon the degree of heat employed in the reaction in sulphonating the dichloranthracene. He had thus not only advanced the industry in this branch of manu-

[1] Jour. Soc. Arts, 1879, 580.

[2] Jour. Soc. Arts, 1879, 577.

facture but he had added to the list of reactions and compounds in chemistry as well.

Hoffmann received from the French color works the *queues d'aniline*, from which he was able to separate para toluidine and the two new bases paraniline and paramidophenol.[1] Other products from the same residues enabled the great investigator to arrive at a knowledge of the mode of formation and structure of rosaniline. Later another French color-maker sent Hoffmann a well crystallized by-product which he recognized as meta-toluylendiamine which he, together with Muspratt, had endeavored to make by synthesis. He found it to have been undoubtedly produced by the Bechamp method from nitrobenzene contaminated with dinitrotoluene.

In his most interesting and valuable address from which many of these illustrations have been obtained, Caro calls attention to other instances of contributions to the advancement of science from this great industry; the use of zinc dust in strongly alkaline solution for the reduction of nitro-bodies was worked out in the factories; safranine was produced technically several years before its structure and mode of formation are made out by Nietzki. The empirical formation of nitro-dracylic acid and β naphthylamin is cited as furnishing contributions to the establishment of isomerism in the classes to which they respectively belong. Aniline blue produced empirically by heating together fuchsine and aniline, was found later by Hoffmann to be triphenylated rosaniline and led him to the recognition that change of color could be produced by substituting an alkyl, phenyl or benzyl radical for hydrogen; and so started the theory, now developed into a law, that color of compounds is a function of structure, and that, in those compounds having antifermentive, therapeutic or toxic action, the influence will vary in intensity with the position of the radical in the molecule. Thus it has been found that ortho-cresol is less active as an antiferment than the meta-compound while this in turn is less intense in its action than paracresol. α Naphthol is more poisonous and more actively antiseptic than β naphthol.

The field of chemical work, here so wonderfully opened up, has done much to bring into closer contact and communion, the professional men and investigators on the one hand and the practical technologists on the other. Professional men find that such union furnishes valuable material for study and most useful suggestion

[1] Proc. Roy. Soc. 1863, 312. [2] Proc. Roy. Soc. 13, 9.

for work. As Hoffmann says, "the technologist is not likely to leave long without utilization any fact of science which may be developed and made valuable from the technical side;" so we find that the benefits which flow from each to each are rapidly increasing from year to year and the distinction formerly made between science and technology is rapidly being broken down, and more cordial, and therefore more useful, relations established. Such union for progressive work was established with profit to both sides by Hoffmann and Nicholson, Graebe and Caro, O. Fischer and E. Heppe and others, and the example of these authorities has been followed by the great manufacturers in all countries by the foundation in the works, of well-equipped laboratories, intended not only for control of processes by analytical methods but for the improvement and extension of processes by careful research methods and the discovery of new principles. Ostwald[1] has clearly set forth the manner in which technology and science may work together in electrical work, in the various directions.

How rapidly this practice has grown will be illustrated by the fact that the great color works, successors to Meister Lucius and Bruning in Höchst, made 1700 to 1800 colors,[2] in 1890, and employ 3000 persons including 70 chemists and 12 engineers.[3] K. Ochler & Co. in Offenbach have 300 workmen and 45 chemists.[4] Other works of large capacity like the Badische Anilin und Soda Fabrik of Ludwigshafen, Bayer & Co. at Elbersfeld, Casella & Co. in Frankfurt am Main, likewise employ large numbers of educated chemists and engineers. This practice now extends to most of the more important manufactures. Its value was early recognized in metallurgy and it has been adopted in other lines As a consequence a demand has been made upon the educational institutions and an influence has been exerted upon the management leading to provision of better facilities for work both in investigation and instruction.

In connection with the working force of the German color factories, it is worthy of remark, that experience has led directors to employ educated engineers alongside the research chemists and so

[1] Chemische Industrie, 1895, 212 from Zeitschrift für Electrotechnik und Electrochemie, 1894, 81.

[2] Ost. Lehrbuch der Technischen Chemie.

[3] Grandhomme. Die Fabriken der Actien-Gesellschaft Farbwerke Meister Lucius und Bruning.

[4] Dir. E. Franck. Zeitschrift für Angewandte Chemie, 1895, 444.

recognize the fact that engineering capacity is necessary to the practical and industrial application of chemical reactions. These reactions effected in the laboratory cannot always be obtained in the works in a large way without the invention of special apparatus, and frequently the most brilliant discoveries in science prove to be nothing more than mere suggestions to the industries, doubtful stepping stones to new processes or new products. The discoveries of aniline and alizarine are examples of this principle. The ammonia soda reaction remained dormant nearly half a century until it was made practical through the genius of Solvay and by means which scarcely involved chemical reactions. The Leblanc soda process, with its beautiful reactions—partly it is true because of the political situation—remained dormant nearly a quarter of a century before the genius of Muspratt restored it to life. The sugar industry, the conception of Margraff and Achard, required the invention and construction of much special apparatus before it could develop into the astonishing dimensions it presents to-day. The Weldon process could be established in the industry only after a most earnest struggle extending over three years, and the final result showed that the complete reaction could be obtained only when working in the largest way.

The study of the ultimate history of any or all of these industries will show that, as they grew, they made demands upon the educated men and so both directly and indirectly contributed to the sum of useful knowledge in nearly all its branches, chemistry included.

For this reason the demand is growing for a combination of chemical and engineering knowledge in the same person. The value of this has been noticed in the lives and works of many of the leaders in chemical work and its recognition among educators is advancing. This is illustrated in the views of Victor Meyer[1] expressed as follows: "I coincide completely with Dr. Lippmann in his wish not only for an extension of his technical instruction in our own university in its present scope, but also for the further development of the same, and I would add thereto the expression of my own opinion that instruction in technical drawing ought not to be omitted in the curriculum of any university, in which numerous young chemists seek their education and are likely ultimately to desire occupation in factories and works." Similar expressions

[1] Chemical News, 1894, 97.

have come from other high authorities in the field of education, and the wisdom of the establishment of the technical schools with provision for thorough education in all the special branches that may find useful application in the different industries, is thoroughly confirmed.

Thus far no reference has been made to the influence of the industries upon the development of analytical chemistry, and perhaps for this there is no need; it is generally accepted, or is fast growing to be, that it is an integral part of all technical work involving any kind of chemical reactions. Meyer[1] says "The industry practically developed volumetric analysis. It was first used by Decroizelles and Vauquelin in an empirical way in the chemical industries with which they were connected and was finally developed rationally by Gay Lussac, who brought it to a state of perfection not greatly improved upon in many respects."

The industries of the earlier chemical history were controlled by other methods of analysis also, crude, perhaps, but serving a useful purpose and forming the foundation of the beautiful systems in use to-day.

In this particular the requirements of the industries of the present day are most exacting. Technical methods as distinguished from scientific methods have passed away, for with rapidity of operation that many of the processes call for, the utmost accuracy must likewise prevail. This is particularly true of the metallurgical industries in which many of the operations must be controlled by analysis from hour to hour. So, too, the utmost accuracy is demanded in all work controlling commercial operations, and frequently the investigation required to confirm the value of these so-called commercial methods, or the data upon which they are based, brings forth results both as to quality and quantity that are most gratifying. In at least two cases that have come to my knowledge the directors of the laboratories of great educational institutions made requests to the directors of large chemical works, asking for descriptions of the analytical methods in daily use in the works in question, and the request was of course cordially granted.

And if the analytical methods of the technical side are recognized as of value, so too are the experimental methods. In the great German chemical works, where large numbers of chemists are

[1] Geschichte der Chemie, 339.

employed, the force is divided into "laboratoriums Chemiker" and "betriebs Chemiker," each class having its appointed work:[1] the first class devoted to the investigation of new ideas in the smaller way in the laboratory, producing new compounds or investigating new reactions, or, still further, controlling by analysis the operations in the works; the second class experimenting in a larger way, with larger apparatus and quantities, and even with the normal factory facilities, with either new principles deduced from the results of factory work, or with processes or products worked out in the laboratory. The results of this combination are extensive and important; most of them are covered by patents, it is true, but they are nevertheless offered to the world, soon become public property and add to the store of knowledge. How much this really amounts to is illustrated by the fact that the records show that the works of Fr. Bayer & Co., patented or described in the first half of 1895 forty-five processes and products, while during the same period there were issued to the house of Meister Lucius and Brunning thirty-seven patents. The number of specifications for chemical patents[2] accepted in Germany from 1889 to 1893 were respectively, 4,406, 4,680, 5,900, 6,430. Of these patents Dr. Freidlander[3] says: "If one could be certain of the excellence of all these compounds, a new era in the color industry would be imminent. Manifestly, however, even the patentees themselves find it difficult to recognize instant practical value in them. The numerous naphthyldiamine, amido-naphthol and dioxynaphthaline sulphonic acids were patented, not, indeed because a special technical interest was claimed for them, but only because they were new and it was scarcely possible at once to determine whether they would be applicable in one direction or another."

In no direction has the application of the methods in the larger way, either in the laboratory or in the works given richer yields in new material than in the varied uses of the electric current in chemical work. It has led to the production of new compounds or has increased the means for production of old ones, and through it additions are constantly being made to the store of material of such composition and properties that they must inevitably lead to further new discoveries or the establishment of new principles or laws. It has added greatly to our knowledge of the reactions of

[1] Caro, Berichte der Deutschen Chemischen Gesellschaft, 25. R. 967.
[2] Chem. Zeit. 1894, 136.
[3] Chem. Zeit. 1894, 1184.

oxidation and reduction and has made new applications of those phenomena possible. In this connection we may refer to the processes of Hoepfner and of Siemens and Halske for the extraction of copper from its solutions whereby as the metal is removed from the solution at the cathode, the reduced salts are oxidized at the anode, and the solutions thus brought to the higher state of oxidation are ready for use on new portions of ore.[1] Similar reactions occur in the new process of Löwenherz for the production of sodium persulphate, a compound new to chemistry and resulting from the application of electricity on a scale more extended than is usually employed for laboratory work. Sulphuric acid and sodium sulphate solutions, separated by a porous diaphragm are electrolyzed with the anode immersed in the sodium sulphate. The resulting compound is comparatively unstable, yielding up its oxygen with the production of acid sodium sulphate. And since this latter may readily be neutralized by sodium carbonate, the new compound is recommended for all uses to which oxidation may be applied.[2]

With the production of hypochlorites and the chlorates we are already familiar. It grows rapidly with the cheapening of artificial power or the utilization of natural power, until eventually the world's demand for them must be covered by materials from this source. The reaction necessary to this is further utilized in the production of such compounds as chloral, iodized phenol and other similar substances.[3]

In the field of reductions reference may with interest be made to the late discoveries of Gattermann and the color works of Fr. Bayer & Co., that electrolysis is readily applied to the production of a large number of compounds not heretofore produced technically but for which technical uses constantly exist. Their earlier discovery of the application of electrolysis to the reduction of nitrobenzene to amido-phenol with intermediate production of phenylhydroxylamine finds wider application than they at first supposed and will doubtless constitute the starting point of a new line of syntheses of the carbon compounds.[4] This reaction is similar to that of zinc dust in alkaline solutions, preferably in alcohol containing calcium chloride whereby, as noticed by Wohl and Bam-

[1] Zeitschrift für Angewandte Chemie, 1893.
[2] Zeitschrift für Angewandte Chemie, 1895, 349.
[3] Chem. Zeit. xix. [4] Chem. Zeit. xix, 1111.

berger, phenylhydroxylamine is produced instead of the aniline produced by the reduction with acetic acid and iron.

The electrical smelting furnace has opened up a wide field of experiment and investigation as fascinating as it is new, and it is to be expected that many additions will be made to the list of new substances through its use. The increased production of chromium and the crystallization of carbon by Moissan,[1] the production of carborundum by Acheson, the production of the various carbides by Moissan, Willson, Borcher and others are of great interest from both the technical and scientific side. Whether the calcium carbide, which has been so much discussed and seems such a valuable material for the production of acetylene, will at once take and hold the high position assigned to it by its inventors is still an open question. But whether it shall find extended application in the industries or not, whether it will prove too expensive to compete with benzene as an enricher of illuminating gas, or as a raw material for the synthesis of alcohol or other substances in a commercial way, it will serve as a convenient and sufficiently inexpensive source of acetylene for experimental purposes and it will therefore without doubt still become the starting point for many valuable investigations. Nikodem Caro[2] has already applied the method of Berthellot to the synthesis of alcohol with acetylene liberated from calcium carbide and shown that the yields are so far from the theoretical amounts that immediate application in this direction is at least doubtful. But the results illustrate the possibilities of the advancement of the science through these technical or semi-technical methods.

It would be impossible in such a discussion as this to cover more than a few of the manifold ways in which the science of chemistry has been advanced by the industries, their wants and their wastes. The former have led to the establishment of the great systems of technical schools provided with the magnificent library and laboratory equipments, the state and national experiment stations, the various official boards and commissions for the study of those questions which immediately affect the general welfare, and from each and all of these sources come reports of advances which are most gratifying. The latter,[3] that is, the industrial wastes, gave us

[1] Chemische Industrie, 1895, 231. [2] Chem. Industrie, 1895, 226.
[3] Roscoe and Schorlemmer, Treatise on Chemistry, III, pt. III, 15.

new elements and new compounds and so furnished the material for the establishment of new laws. The soap-boiler's lye gave iodine, the wastes of the salt gardens gave bromine, the mother liquors from the springs gave caesium and rubidium, the acid chambers selenium and thallium and the mines and metallurgical works gave gallium and germanium.

Whether we consider this side of the subject of the advancement of our science from one direction or another, we shall find ample encouragement for combination of forces and for closer union of professional and technical workers in our general field of activity. For the benefits from one side must bring reciprocal benefits from the other.[1] The principle of action and reaction is as true and as applicable here as in the great domain of physics. Necessity is the most natural stimulant to effort, and honest investigation must call to her aid all knowledge whatever its source and all methods however they may be acquired, and where this is the moving spirit progress is most active. Dr. Ostwald says most justly that "the secret of German industrial chemistry is the recognition that science is the best practice." Is it not equally true that practice, which leads to the development of truth, is the best science?

[1] Caro. Ber. d. deutch. Chem. Gessells. 25, R. 991. Meyer. Geschichte der Chemie, 469–470.

PAPERS READ.

On the volumetric composition of water. By Prof. Edward W. Morley, Cleveland, Ohio.

[ABSTRACT.]

The author made, some years ago, a determination of the ratio in which oxygen and hydrogen gases combine, when the volumes were measured in tubes of about twenty millimetres. The ratio formed did not agree well with what would be expected from our knowledge of the deviations of the two gases from Boyle's law. The matter has therefore been again examined by a different method. Scott has also repeated his determination of the same ratio, and has found a value much larger than either of us found in our earlier experiments. Since he had carried out experiments in which considerable volumes of gas were measured, not in eudiometric tubes, but in vessels nearly globular in shape, the author chose first to use a method in which the density of an electrolytic mixture of hydrogen and oxygen was used to determine the proportion of the two gases in the mixture by taking account of the deviation of the gases from Boyle's law.

Then the composition of the mixture was determined by eudiometric analysis, exploding quantities as large as ten litres. The excess of hydrogen in the electrolytic mixture being subtracted from the ratio of hydrogen to oxygen found in the mixture, the ratio of the volumes in which the gases combine was determined. Since Scott's value depending on volumes of a litre or two, and the author's depending on volumes of fifteen litres or more, are concordant, it is hoped that the truth has been reached.

[This paper will be printed in Smithsonian Contributions to Knowledge.]

The coloring matter of natural waters; its source, composition, and quantitative measurement. By Ellen H. Richards and J. W. Ellms, Massachusetts Institute Technology, Boston, Mass.

[ABSTRACT.]

So deep-seated in the mind of the average citizen is the prejudice against the amber colored waters of most of the New England streams, so happily named by Thoreau "Meadow Tea," that it is only when science brings up strong reserves that city authorities and water boards are able to make any efficient fight against it. It is only by actually filling up the well, or

removing the pump, that a Board of Health can prevent the use of the clear, cold, colorless, highly polluted well-water, no matter how abundant and free the tepid, brown water supply of the town may be.

While there must have been some ground for so strong and so universal a feeling of danger, experience has certainly shown that a carefully protected and properly stored brown water is a perfectly wholesome as well as a most available supply for many towns. The water of the Dismal Swamp is sought for by vessels to take for three-year cruises and the keeping qualities are excellent of other brown waters after extraneous matters which may have been carried along with the streams have been removed, either by natural processes or by storage in reservoirs.

The source of the brown color is to be found in the fallen oak, maple and other leaves and the peaty soil of the swamps.

The color of any given water is usually deepest in May and June when the leaves and surface soil which have been soaked all the spring drain off the highly carbonaceous solution resulting from the slow decay of the woody tissue; the sugary and gummy matters dissolved out by the fall rains yielding water of a lighter color.

In the case of ordinary tea this coloring matter is developed by slow fermentation which causes a decomposition of the more unstable juices, and it is probable that the oak, maple and elm leaves undergo a like fermentation when bedded under the snow or submerged under water.

When any organic substance as wood leaves and the like is treated with strong sulphuric acid, a decomposition occurs more or less complete and the result may be a mass of nearly pure carbon, or a gummy substance, soluble in water, with a brown color. When sugar alone is heated gently it parts with a portion of the elements of water becoming richer in carbon as the process is pushed farther. The result is a brown substance soluble in water known as caramel. But the most instructive instance of the production of this characteristic brown substance is perhaps in the case of the well-known colorimetric determination of carbon in steel. The iron carbide, Fe_3C, yields a soluble brown color which compares very closely with the color of dark brown surface waters. These facts all indicate that this brown color is imparted to aqueous solutions by the same compound of carbon or by closely related compounds.

(Then follow tabular statements of experiments on this coloring matter, derived from various sources; and curves, showing the relation between oxygen consumed and the color of certain waters.)

Dating back to the time when the brown color of water was supposed to be a bar to its use, analysts began to recognize the fact that fixed standards could not be applied to all waters from all sources alike and that a certain quantity of albuminoid ammonia invariably accompanied the brown color of perfectly wholesome water and somewhat in proportion to that color. It became of importance therefore to be able to estimate the relative depth of color in different waters. For this some standard was of course required.

(Then follow a discussion of the various standards proposed, an ex-

hibition of Lovibond's Tintometer with a discussion of its merits, and a description of the standards used in the work of the State Board of Health of Massachusetts, and a comparison of the Tintometer readings.)

AMMONIUM PHOSPHOMOLYBDATE AND THE REDUCING ACTION OF ZINC IN THE REDUCTOR By ANDREW A. BLAIR and J. EDWARD WHITFIELD, Philadelphia, Pa.

[ABSTRACT.]

THIS paper contains details of a careful determination of the chemical composition of ammonium phosphomolybdate, and an examination of the reducing action of zinc upon molybdic acid. The results have a direct bearing on the determination of phosphorus and phosphoric acid by the molybdate method.

[This paper will be printed in Journal Amer. Chem. Society.]

ON THE USE OF THIOACETIC ACID AS A LABORATORY REAGENT. By Prof. THOMAS H. NORTON, University of Cincinnati, Ohio.

[ABSTRACT.]

A description is given of the results attending the use of Thioacetic acid as a substitute for hydrogen sulfid as a laboratory reagent, proposed by Schiff and Tarugi in 1894. The author finds that the reagent replaces most admirably hydrogen sulfid for qualitative analysis, and possesses manifold advantages over the latter in the hands of the ordinary student, while it offers a most desired degree of security to the toxicologist.

Experiments are described relative to the economic production of the reagent, showing that, by the simple addition of powdered glass to the phosphorus pentasulfid and glacial acetic acid employed, the yield can be so increased that the cost is reduced to about $7.00 per kilogram.

The question of expense is the only feature affecting its widespread use.

[This paper will be printed in Journal of the Am. Chem. Soc.]

THE PHOSPHORUS CONTAINED IN PHOSPHO-CEREAL. By Prof. THOMAS H. NORTON, University of Cincinnati, Ohio.

[ABSTRACT.]

A STUDY of the amount of phosphorus obtained in the soluble form by the aqueous extraction of so-called phospho-cereal, a food preparation from the bran of cereals.

It was found to contain 5.18% of phosphorus pentoxid, but of this slightly less than one-half can be extracted by water and that only after prolonged decoction.

The soluble form of the phosphorus is shown not to be that of a hypophosphite.

[This paper will be printed in Jour. Am. Chem. Soc.]

THE PERIODIDES. By Prof. ALBERT B. PRESCOTT, University of Michigan, Ann Arbor, Mich.

[ABSTRACT.]

A classification and discussion of the periodides in general, and those of organic bases in particular, with more attention to those of the pyridine bases. Drawn historically from the literature and experimentally from work done in the laboratory and now communicated (to this Association) in accompanying papers by the writer and co-workers with him. Known periodides are classified:

1. Metallic periodides, those of a single and those of a double base.
2. Periodides of ammonium, and so far as obtained, those of the other inorganic bases of the nitrogen family of elements. Including metallo-ammonium periodides.
3. Periodides of organic bases. Of quaternary and tertiary ammonium amine type, also of the corresponding bases of phosphorus, arsenic, and antimony.
4. Periodides of iodonium (V. Meyer).
5. Periodides of aromatic sulphon derivatives (Kastle and Hill).
6. Acid periodides; metallo-organic polyiodides, and mixed polyhalides.

[This paper will be printed in Jour. Am. Chem. Soc.]

PERIODIDES OF PYRIDINE. By Prof. A. B. PRESCOTT and P. F. TROWBRIDGE, University of Michigan, Ann Arbor, Mich.

[ABSTRACT.]

DESCRIPTION and analysis of *Pyridine Alkyl Periodides*:

1. Pyridine methyl pentiodide, three preparations.
2. Pyridine methyl diiodide, two preparations.
3. Pyridine methyl triiodide, four "
4. A methyl tetra-pentiodide (?)
5. Pyridine methyl octaiodide, two "
6. Pyridine ethyl triiodide, one preparation.

Methods of preparation of the above named.

Periodides of the Amine, and of the Tertiary Ammonium Base:

1. Pyridine tetraiodide, four preparations.
2. The pyridine hydrogen pentiodide of Dafert.

Discussion of the distinctions between 1 and 2 last numbered, and upon types of organic periodides.

The methods of estimation of the iodine of periodides.

[This paper will be printed in Jour. Am. Chem. Soc.]

A FEW PYRIDINE ALKYL NORMAL IODIDES. By Prof. ALBERT B. PRESCOTT. University of Michigan, Ann Arbor, Mich.

[ABSTRACT.]

FROM the work of Mr. S. H. Baer, in the laboratory of the writer, the preparation and description of

1. Pyridine propyl normal iodide.
2. Pyridine isopropyl normal iodide.

From the work of Mr. P. F. Trowbridge, in the same laboratory, notes upon the properties and constants of

1. Pyridine methyl iodide (Anderson, Lange).
2. Pyridine ethyl iodide (Anderson).

Also as to convenient preparation of these.

[This paper will be printed in Jour. Am. Chem. Society.]

DIPYRIDINE TRIMETHYLENE DIBROMIDE. By R. F. FLINTERMAN and Prof. A. B. PRESCOTT, University of Michigan, Ann Arbor, Mich.

[ABSTRACT.]

THE preparation of this compound; its analysis, the determination of its constants and its molecular weight, supporting the formula

$$\underset{\dot{B}_2}{C_6H_5N}-CH_2\cdot CH_2\cdot CH_2-\underset{\dot{B}_2}{C_5H_2N}$$

Also some discussion of the report of Davidson upon dipyridine ethylene dibromide, and respecting the marked difference between pyridine and the aliphatic tertiary bases in the formation of addition compounds with dihalogen substitution products, a difference already expressed by G. Kleine.

[This paper will be printed in Jour. Am. Chem. Society.]

CAMPHORIC ACID. By Prof. W. A. NOYES, Rose Polytechnic Institute, Terre Haute, Indiana.

[ABSTRACT.]

IN my last paper on this subject several new derivatives of camphoric acid were described whose conduct can be easily explained only on the supposition that camphoric acid is a cyclic derivative of succinnic acid and that one carboxyl is attached directly to a CH group, while the other is united to a carbon atom which is not combined directly[1] with hydrogen. Since that paper was written the cis-campholytic acid has been reduced to a dihydro acid and from this the α-brom derivative has been prepared. Treatment of this with alcoholic potash regenerates the cis-campholytic acid, giving positive and independent proof of the α β position for the double union in that acid.

The only formulæ which have been proposed for camphoric acid that are consistent with these facts are those of Armstrong[2] and of Collie.[3] Xylylic acid

$$C_6H_3\begin{cases} CH_3 & 1. \\ CH_3 & 3. \\ CO_2H & 4. \end{cases}$$

has been reduced and the α-brom derivative of the resulting hexahydro acid prepared. This, on treatment with alcoholic potash, gives, chiefly, a liquid acid with a very small amount of a solid acid which is not cis-campholytic acid. The liquid acid is not converted into cis-campholytic acid by dilute sulphuric acid and is not, therefore, cis-trans campholytic acid. These facts furnish quite conclusive proof that Armstrong's formula for camphoric acid is not the true one.

[This paper will be printed in the American Chemical Journal.]

THE CONSTITUTION OF THE 1:4 DIKETONES. By Prof. ALEX. SMITH, University of Chicago, Chicago, Ill.

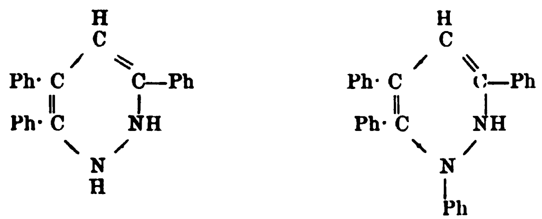
[ABSTRACT.]

THE fact that the 1:4 diketones interact with phenylhydrazine and hydroxylamine, giving compounds by loss of water, has been supposed to prove that those bodies really contain two CO groups, but no effort whatever has been made to show experimentally that the products are really hydrazones and oximes. On the other hand all the known properties of these bodies, such as their convertibility into furfurane, pyrrole

[1] Amer. Chem. Jour., XVII, 421.
[2] Ber. d. Chem. Ges., XVI, 2260, Wallach, *ibid.*
[3] *Ibid.*, XXV, 1116.

and thiophene derivatives require the use of the hydroxyl formula for their explanation (R. COH = CH — CH = COH. R). Since it has been shown that phenylhydrazine can form hydrazides with bodies like aceto-acetic ether and phloroglucinol, the mere fact that it interacts with a substance can no longer be regarded as showing that the latter is a ketone. It would seem, therefore, that, till the contrary is proved, the 1:4 diketones should be described as unsaturated alcohols. This paper describes experiments which support this theory.

Desylacetophenone forms with hydrazine and phenylhydrazine compounds of the constitution :—



and other 1:4 diketones produce precisely similar bodies whose formation can only be explained by the "labile" formula.

The properties of the diphenylhydrazid of acetonylacetone can likewise only be explained on the assumption that the body is a diphenylhydrazide and not a diphenylhydrazone.

Some new color reactions. By Prof. C. Loring Jackson, Harvard University, Cambridge, Mass.

[ABSTRACT.]

Colors produced by Sodic ethylate with $C_6CH_3 H_2(NO_2)_2$ Br or $C_6CH_3 H_2(NO_2)_2$ (C_6H_5NH) and with C_6COOH $H_2(NO_2)_2$ Br or C_6COOH $H_2(NO_2)_2$ (C_6H_5NH) 1, 3, 4, 5. These observations overthrow the theory proposed by Victor Meyer to explain the colors from $C_6CH_3 H_3 (NO_2)_2$ 1, 3, 5.

[This paper will be printed in Amer. Chem Journal.]

The teaching of organic preparations: the time. scope, methods and previous preparations. By Prof. Paul C. Freer, University, of Michigan, Ann Arbor, Mich.

The introduction to the discussion is to advocate a method of laboratory instruction in organic preparations which is to be based upon the outlines of some one of the great organic researches.

The subject was formally discussed by Prof. C. L. Jackson, Dr. W. A. Noyes, Prof. T. H. Norton, Dr. A. B. Prescott, and Prof. A. A. Noyes.

THE CONSTITUTION OF TETRINIC ACID. By Prof. PAUL C. FREER, University of Michigan, Ann Arbor, Mich.

[ABSTRACT.]

THE paper demonstrates that the constitution of tetrinic acid is to be represented by the formula

$$\left.\begin{array}{l} CH_2 \\ | \\ COH \\ \| \\ CCH_3 \\ | \\ COO \end{array}\right]$$

AGRICULTURAL CHEMISTRY. By Prof. H. W. WILEY, U. S. Department of Agriculture, Washington, D. C.

AGRICULTURAL chemistry is a cosmopolitan science. It was founded by Liebig of immortal memory. Its early apostle in France was Boussingault; in England, Gilbert; in America, Johnson. It is presumably that science most nearly allied to the sustenance of human life and thus lies nearer than any other to the heart, or perhaps the stomach. of humanity. Its home is wherever a plant grows. Its devotees are found wherever a plowshare turns the soil. Its base lies in the study of the composition of the soil and the constitution of plants. Its superstructure rises high enough to touch the most abstruse questions of mineral and vegetable physiology and metabolism. Turning from philosophy to facts, we find this science linked indissolubly with the greatest industry of the world. There is scarcely a field or a forest which has not felt the impress of its power. From the field its domain has extended to the factory and the guidance and advice of the chemist are sought for the further preparation of foods and fabrics for the use of man. It has also secured a place in the domain of public and advanced instruction, and even the conservatism of the great universities has yielded to agricultural chemistry a prominent place in the curriculum of studies. Both in this country and in Europe, hundreds of special schools and experiment stations are found devoted largely to the service of agricultural chemistry and its coordinate branches of science.

The art of fertilizing the fields, at first purely empirical, has become an exact science. The methods of saving and recovering waste fertilizing products, at the present time, render many great industries possible which otherwise would have to yield to the fierce competition which every human endeavor has to meet in this end of the century. Further than this the paternal efforts of agricultural chemistry extend and seek to recover from the mine and from the sea the elements of fertility apparently forever lost during the centuries that have passed.

The science of agricultural chemistry acknowledges, without stint, its indebtedness to the other fields of chemical work. In its very beginning it was the simple use of the principles of mineral analysis, applied to the soil and its products By this means the parts of the plants which were derived directly from the soil were determined and the surprising fact was thus developed that nearly the whole of the vast product of vegetable growth is a free gift of heaven and not chargeable to the soil. This was the point of union between agricultural chemistry and meteorology, and the basis of the science of meteorology applied to agriculture. The supply of carbon dioxid and water to the growing plant becomes thus a problem of the profoundest interest to agriculture, and the chemist and physicist have thus been led to study the great problems of precipitation, drainage and irrigation as affecting the products of the field. The best methods of disposing of an excess of rainfall, with the minimum loss of plant food due to percolation of water through the soil, are of no less importance. In connection with this, that treatment of the soil, by chemical and physical means, which will best prepare it to distribute the supply of moisture available to the advantage of the growing plant, has been carefully studied.

Agricultural science has also drawn freely on the resources of organic chemistry. In agricultural products are presented to the student some of the most complicated as well as interesting organic compounds. In the growth of the plant are seen the wonderful resources of the vegetable cell in the way of chemical activity. The most renowned achievements of modern synthetic chemistry have consisted in the reproduction of some of the simpler forms of vegetable organic compounds. It will be admitted, without doubt, that the simple sugars are the least complicated of organic vegetable products, and these have been at last successfully made in the laboratory. The step from a hexose to a hexobiose seems indeed a short one, and yet it has not been taken. Only step by step must we expect the onward progress of synthesis until, for instance, a starch is reached. Yet in the progress of organic synthetic chemistry already accomplished, great good has come. The exact chemical relations of the sugars to the aldehyds, ketones and polyatomic alcohols have been established and the bonds which unite the organic chemistry of man to that of nature clearly distinguished. On a former occasion, in an address to the Chemical Society, I have pointed out the futility of the expectation that synthetic organic chemistry will ever be able to take the place of agriculture, but the debt agriculture owes it is one of great and constantly increasing magnitude.

Not of less practical importance to agriculture has been the recent progress in our knowledge of that indefinite complex which has so long passed under the misnomer of "nitrogen-free extract." With the exception of the facts that it is not nitrogen-free and that it is not an extract, the name may do well enough. At least some agricultural chemists have an idea of what the term signifies, and to others it serves the purpose of the physician's malaria, permitting to designate, in a fairly

mysterious way, a something of which nothing is known. The constitution of the greater part of this complex body is now known and the proportions of cellulose and of pentosans which it contains can be determined with a fair degree of definiteness. We should deem it a matter for congratulation to be assured that the day is fast approaching when the agricultural chemist will no longer be called on to determine forty per cent or more of a cattle food "by difference."

In late years not only has organic chemistry helped us in the way of a better understanding of the composition of the carbohydrates, but it has also pointed out to us some of the main points in the constitution of those most valuable products, the vegetable proteids. We are away behind our digestive organs in our understanding of these bodies and have been accustomed in practical work to place all proteid matter together in a single class. But there is no doubt of the fact that the vegetable proteids differ as much among themselves as those of animal origin, and at last the chemist is able to distinguish between them. Even if it should prove that there is little difference in their food value, yet it must be conceded that a knowledge of their structural differences, together with the several contents of nitrogen found therein, will prove in the end of the greatest advantage to the agricultural chemist.

The relations of agriculture to pedagogic chemistry have already been mentioned. In many of our public schools it is thought to be quite as important to teach the child something about the life of the field and the orchard as to drill him in the geography of Johore. How plants and animals grow is a theme which will some day be developed in every school in the land. Naturally, in agricultural colleges the pedagogic side of agricultural chemistry receives due consideration; but, alas! with these institutions it is sometimes *nomen et praeterea nihil*. In these cases, agricultural chemistry must often give way to a heterochronistic psychology. But on the other hand, many of our universities have recognized the need of such instruction and have provided properly therefor. Merely material considerations should induce all our higher institutions of learning to provide for advanced instruction in agricultural chemistry, for just now there is, and for years to come there will be, a large demand for young men well trained in this direction. It will not be many years before it will be required of every well-equipped university to provide liberally for the professional education of the young men who are to take charge of the agricultural colleges and experiment stations of the country.

In its relations to bacteriology, agricultural chemistry is also a debtor. In the life history of those minute vegetable organisms which exert so profound a chemical action on many bodies, has been found the solution of the problem of those fermentations which prepare for use the nitrogenous foods of plants. The successive conversion of organized nitrogen into ammonia, nitrous and nitric acids, is a process of the most vital importance to plant life. It is true that these activities were exerted for several millions of years without our knowing anything about them, and

they would doubtless go on until the end of time if our knowledge of them should entirely cease and determine. Nevertheless, the value of what little knowledge we now possess seems almost the groundwork of scientific agriculture. The microorganisms which nitrify organic nitrogenous compounds, as well as those which act in the opposite direction, viz., in reducing nitrates to a lower form of oxidation, are of the utmost importance to agricultural chemistry. It is not beyond the range of possibility that a barren field may be rendered fertile by securing conditions favorable to nitrification and then seeding the soil with a few active nitrifying ferments.

Quite true it is, already, that any scheme for an analysis of a soil, which leaves out of consideration the determination of nitrifying activity, is far from complete. The action of bacteria on the ripening of cream and of cheese is a matter of but little less importance The fermentation of cream and of cheese is already as much of an art as the fermentation of malt in the manufacture of beer. In the curing of tobacco the same activity is discovered and the day is not far distant when commerce in high-bred tobacco bacteria will be an established fact. In short, we may look forward to the day when the bacteria active in agriculture will be carefully cultivated and a bacterial herd book will be found along with those of the Jersey cow and the Norman horse. Agricultural chemistry makes demands on every science which can aid it in the production of food and in the advancement of rational agriculture.

But we may go still a step further and follow the crude food into the factory and the kitchen. From the knowledge of the action of ferments mentioned above, the great art of food preservation has been created. The sterilization of food products and their preservation from the further action of destructive ferments are some of the practical developments of rational agricultural chemistry. This method of food preservation is infinitely preferable to that other simpler process which consists in adding to the food a substance which paralyzes the further action of microorganisms. Happily, agricultural and analytical chemistry have provided a certain method of detecting chemicals thus used for food preservation.

The conversion of foods into appropriate digestive forms and the study of their nutritive power mark the final step in agricultural chemistry, in its control of food products. In this relation it comes into intimate contact with hygiene and animal physiology, thus almost completing the circle of intimate union with nearly all the leading sciences. Intimately associated with this branch of the subject are the control of the purity of the food itself and the detection of the adulterations to which it may be subjected.

The thoughts suggested in the foregoing pages are those that have come to me amid a multitude of distractions as those suited, at least in part, to meet the views of your presiding officer in asking me to introduce the theme of agricultural chemistry for discussion before the section I now yield the floor for a more particular treatment of some of the branches of the subject.

A PROPOSED SCHEDULE OF ALLOWABLE DIFFERENCE AND OF PROBABLE LIMITS OF ACCURACY IN QUANTITATIVE ANALYSES OF METALLURGICAL MATERIALS. By Prof. E. D. CAMPBELL, Ann Arbor, Mich.

WITHIN the past twenty years, metallurgical practice has grown to depend more and more upon a chemical knowledge of the material employed in the various operations. On account of this dependence it has become necessary to have accurate as well as rapid methods for the determination of the elements which take an active part in the different processes.

Many methods for the determination of the various elements usually met with in metallurgical work have been proposed, each having its own claim for accuracy or rapidity or both; but, as will be seen from the efforts of the International Committee on the Analysis of Iron and Steel, we are far from having perfect methods for metallurgical analysis.

There are many sources of error in ordinary quantitative determinations, which, while they can be partially avoided, can never be wholly overcome. Among these may be mentioned such errors as arise from solubility of precipitates, solubility of apparatus in which operations are performed, impurities in chemicals, inaccurate graduation of volumetric apparatus, unavoidable error in accuracy of weighing and, last but not least, errors due to what may be termed the personal equation, the presence or absence in the operator of that manipulative skill which distinguishes an expert from a clumsy worker. Since we cannot expect absolute agreement in results it may be asked how closely should quantitative determinations agree. This question can not be answered by a single figure since the unavoidable errors in the various determinations differ according to the element determined and the method used in the analysis. Just how great a difference between determinations should be allowed and what the probable limit of accuracy which may be hoped for, is largely a matter of judgment based upon the examination of the results obtained by different chemists, known to be careful operators, working upon the same material.

Basing our judgment upon the usual errors of analysis, upon the commercial requirements of accuracy and upon the unavoidable sources of error, we would propose the following schedule of allowable differences and of probable limits of accuracy for discussion in the section. In the table below, the first column shows the element or constituent determined; the second, a formula for calculating the difference which might be reasonably expected between the results of two chemists working upon the same material; and the third column shows a formula for calculating the probable minimum error which may be hoped for. To take an instance: suppose chemist A reports the phosphorus in a specimen of steel as .076%, then by the formula in the table we might expect B to report .076±.00352%, and from the third column we could not hope to reduce the error to less than .00058%.

Element or constituent.	Allowable difference of per cent.	Probable limit of accuracy.
Iron and Steel.		
Graphitic carbon	$\pm[.050+(.02\times Cg)]$	$\pm[.005+(.005\times Cg)]$
Cast iron Combined carbon	$\pm[.050+(.02\times Cc)]$	$\pm[.005+(.005\times Cc)]$
Carbon in steel	$\pm[.010+(.02\times C)]$	$\pm[.002\quad(.003\times C)]$
Silicon–S	$\pm[.005+(.02\times Si)]$	$\pm[.002+(.003\times Si)]$
Sulphur–S	$\pm[.003+(.03\times S)]$	$\pm[.0005+(.005\times S)]$
Phosphorus–P	$\pm[.002+(.02\times P)]$	$\pm[.0002+(.005\times P)]$
Manganese–Mn in cast iron and steel	$\pm[.005+(.04\times Mn)]$	$\pm[.001+(.005\times Mn)]$
Manganese–Mn in spiegels, ferro, etc.	$\pm[.050+(.004\times Mn)]$	$\pm[.005+(.001\times Mn)]$
Nickel–Ni	$\pm[.050+(.02\times Ni)]$	$\pm[.005+(.005\times Ni)]$
Analysis of Ores.		
Silica–SiO_2	$\pm[.050+(.006\times SiO_2)]$	$\pm[.005+(.001\times SiO_2)]$
Alumina–Al_2O_3	$\pm[.030+(.003\times Al_2O_3)]$	$\pm[.005+(.001\times Al_2O_3)]$
Ferric Oxide–Fe_2O_3	$\pm[.030+(.003\times Fe_2O_3)]$	$\pm[.005+(.001\times Fe_2O_3)]$
Iron–Fe	$\pm[.020+(.003\times Fe)]$	$\pm[.004+(.001\times Fe)]$
Manganese–Mn	$\pm[.050+(.002\times Mn)]$	$\pm[.005+(.001\times Mn)]$
Calcium oxide–CaO	$\pm[.050+(.002Ca\times O)]$	$\pm[.010+(.001\times CaO)]$
Magnesia–MgO	$\pm[.050+(.010\times MgO)]$	$\pm[.005+(.002\times MgO)]$
Phosphorus–P	$\pm[.002+(.02\times P)]$	$\pm[.0002+(.005\times P)]$
Phosphorus pentoxide P_2O_5	$\pm[.005+(.02\times P_2O_5)]$	$\pm[.0005+.005\times P_2O_5)]$
Combined water	$\pm[.050+(.010\times H_2O)]$	$\pm[.010+(.001\times H_2O)]$
Potassium oxide–K_2O Sodium oxide–Na_2O	$\pm[.050+(.020\times K_2O)]$	$\pm[.005+(.005\times K_2O)]$
Sulphur–S in iron ore.	$\pm[.005+(.030\times S)]$	$\pm[.001+(.003\times S)]$
Sulphur in pyrite	$\pm[050+(.004\times S)]$	$\pm[.005+(.0002\times S)]$
Lead–Pb	$\pm[.050+(.003\times Pb)]$	$\pm[.005+(.0005\times Pb)]$

Zinc–Zn	$\pm[.050+(.003\times Zn)]$	$\pm[.005+(.0005\times Zn)]$
Copper–Cu	$\pm[.030+(.003\times Cu)]$	$\pm[.005+(.001\times Cu)]$
Nickel–Ni	$\pm[.030+(.003\times Ni)]$	$\pm[.005+(.001\times Ni)]$
{ Arsenic–As Antimony–Sb	$\pm[.050+(.010\times As)]$	$\pm[.002+(.001\times As)]$
Tin–Sn	$\pm[.010+(.010\times Sn)]$	$\pm[.005+(.001\times Sn)]$
Coal and Coke.		
Moisture	$\pm[.050+(.020\times H_2O)]$	$\pm[.005+(.005\times H_2O)]$
Volatile hydro-carbon	$\pm[.050+(.010\times \text{hydro})]$	$\pm[.010+(.001\times \text{hydro})]$
Fixed carbon	$\pm[.050+(.010\times C)]$	$\pm[.010+(.001\times C)]$
Sulphur–S	$\pm[.020+(.030\times S)]$	$\pm[.005+(.003\times S)]$
Ash	$\pm[.050+(.005\times \text{Ash})]$	$\pm[.005+(.001\times \text{Ash})]$
Phosphorus	$\pm[.002+(.02\times P)]$	$\pm[.0002+(.005\times P)]$

THE MANUFACTURE OF CALCIUM CARBIDE. By Prof. J. T. MOREHEAD and G. DE CHALMOT, Spray, N. C.

A GENERAL outline of the Willson process for making carbide is given. The authors have made experiments on a large scale in the works of the Willson Aluminum Company in Spray, N. C., and have proved that the commercial production of calcium carbide is very practical. The material used is a mixture of lime and very finely ground coke. The coke should not contain over 10% of ash. The electric furnace used in Spray, N. C., is heated by an alternating current which proves that electrolysis does not play a part in the formation of calcium carbide. The carbide is always obtained in one solid piece of from 300 to 500 pounds That part of the mixture of coke and lime which is not converted into carbide is not at all acted on with the exception that some carbon burns out. It can again be used for making carbide after carbon has been added. On the outside of the pieces of carbide there is a little slag amounting to about 5% of the weight. This slag consists mainly of carbon. The commercial carbide contains about 10% of free oxide of calcium and 5% of other impurities. If the proper directions were followed the output of carbide was equivalent to 52.90 and 52.72 cubic feet of acetylene gas per horse power in twenty-four hours. The horse power meant here is the electrical horse power at the end of the electrodes. If unslacked lime was used the

output of carbide per horse power was about 15% better than if slacked lime was used. The unslacked lime is also preferable for other reasons. If the voltage was increased to 100, the output was better than at lower voltage.

Kind of Lime.	Volts.	H. P.	No. of Experiment.	Cubic feet of gas per H. P. in 24 hrs.
Unslacked	100	205-214	5	49.88
"	65-75	114-165	7	47.23
Slacked	100	200-214	3	43.15
"	75.85	159-200	5	38.71
"	65	150	7	38.55

The amperage should not be more than 2000 for a furnace as it is used in Spray, N. C., and where the carbon-pencil electrode is 8x12 inches. The heat evolved by a current of 100 volts and 1700 amperes seems to be the largest with which carbide can be economically made in one furnace as it is used in Spray. If the voltage is increased, the quality of the carbide becomes inferior. The mixture used for making carbide contains about sixty-five parts of C. and 100 of CaO. At a higher voltage more carbon is required. To a certain extent the quality of the carbide varies directly with the percentage of carbon in the mixture. It is however not economical to make entireiy pure carbide, for the largest amount of acetylene gas per horse power is obtained if carbide of five cubic feet of gas per pound is made. The production of carbide per horse power in a furnace with vertical electrodes is as good after two feet of carbide have been formed as in the beginning.

It is therefore practical to make a continuous run of several hours (3 to 9) without removing the carbide. As an average of ten experiments it was found that 2456 pounds of CaO and 1674 pounds of C. are necessary to form one ton (2000 lbs.) of commercial calcium carbide in an open furnace. The authors hold that they can reduce these figures materially, by using a shut furnace from which draught is excluded and in which the volatilized lime is condensed and thereby saved.

A SECOND MODIFICATION OF PICRYLMALONIC ESTER. By Prof. C. LORING JACKSON, Harvard University, Cambridge, Mass.

[ABSTRACT.]

NEW form of $C_6H_2(NO_2)_3CH(COOC_2H_5)_2$ formed from the older by inoculation.

[This paper will be printed in Amer. Chem. Journal.]

QUANTITATIVE EXERCISES IN GENERAL CHEMISTRY. By Dr. H. W. WILEY, U. S. Dept. of Agriculture, Washington, D. C.

[ABSTRACT.]

A brief résumé of results obtained from students on introducing quantitative exercises into laboratory work in general chemistry.

SOME INQUIRIES RESPECTING INHERENT LIMITATIONS IN THE ACCURACY OF ANALYTICAL WORK IN GENERAL. By Dr. A. B. PRESCOTT, Ann Arbor, Mich.

[ABSTRACT.]

THIS was an introduction to discussion of topics in analytical chemistry.

BIBLIOGRAPHY AS A FEATURE OF THE CHEMICAL CURRICULUM. By Dr. H. CARRINGTON BOLTON, New York, N. Y.

[ABSTRACT.]

THE author discusses the best method of rendering students familiar with the literature of chemistry.

DOUBLE SALTS AND ALLIED COMPOUNDS. By Prof. CHAS. H. HERTZ, Univ. of Georgia, Athens, Ga.

CONTRIBUTION TO THE KNOWLEDGE OF THE LAWS OF THE VELOCITY OF POLYMOLECULAR REACTIONS. By Dr. ARTHUR A. NOYES, Mass. Inst. Tech., Boston, Mass.

REMARKS ON A SPECIFIC FORM OF CELL METABOLISM. By ERNEST E. SMITH, New York, N. Y.

REMARKS ON INTERNATIONAL STANDARDS OF ANALYSIS OF STEEL. By Dr. C. B. DUDLEY, Altoona, Pa.

RECENT PROGRESS IN PHYSICAL ANALYSIS OF SOILS. By Prof. MILTON WHITNEY, Washington, D. C.

CHEMISTRY OF FOODS AND NUTRITION. By Dr. W. O. ATWATER, Middletown, Conn.

SOME POINTS CONNECTED WITH THE CHEMISTRY AND PHYSICS OF METABOLISM. By Dr. W. O. ATWATER, Middletown, Conn.

FOREIGN LABORATORY NOTES. By Prof. W. P. MASON, Troy, N. Y.

PRODUCTS OF PATHOGENIC BACTERIA. By D. A. DE SCHWEINITZ, Washington, D. C.

ACCURACY IN METALLURGICAL ANALYSIS. By Dr. FREDERICK P. DEWEY, Washington, D. C.

JOURNAL REVIEWS. By Dr. W. A. NOYES, Terre Haute, Ind.

CHEMISTRY AS A LIBERAL EDUCATION. By Dr. PETER T. AUSTEN, Brooklyn, N. Y.

THE TEACHING OF QUANTITATIVE ANALYSIS. By Dr. G. C. CALDWELL, Ithaca, New York.

RELATIVE ORDER OF THEORY AND DESCRIPTION IN THE TEACHING OF GENERAL CHEMISTRY. By Prof. JAMES LEWIS HOWE, Washington and Lee Univ., Lexington, Va.

INSTRUCTION IN GENERAL CHEMISTRY. By Prof. C. LORING JACKSON, Harvard Univ., Cambridge, Mass.

LABORATORY CONSTRUCTION AND EQUIPMENT. By Prof. T. H. NORTON, Univ. of Cincinnati, Ohio.

DISCUSSION ON IMPORTANT PHASES OF DIDACTIC CHEMISTRY. Introduction by Prof. THOMAS H. NORTON, University of Cincinnati, Ohio.

THE MAJOR PREMISE IN PHYSICAL CHEMISTRY. By Prof. R. B. WARDER, Washington, D. C.

SATURATED SOLUTIONS AND THE MASS LAW. By Prof. W. D. BANCROFT, Newport, R. I.

RECENT VIEWS ON THE PERIODIC SYSTEM. By Dr. F. P. VENABLE, Chapel Hill, N. C.

HELIUM AND ARGON. By Prof. H. N. STOKES, U. S. Geological Survey, Washington, D. C.

Thirteenth Annual Report of the Committee on Indexing Chemical Literature.

The Committee on Indexing Chemical Literature presents to the Chemical Section its thirteenth annual report.

During the twelve months which have elapsed since the last report the following bibliographies have been printed:—

1. Indexes to the Literature of Cerium and Lanthanum. By W. H. Magee. Smithsonian Miscellaneous Collections, No. 971. Washington, 1895. 43 pp. 8vo.

2. Index to the Literature of Didymium, 1842–1893. By A. C. Langmuir. Smithsonian Miscellaneous Collections, No. 972. Washington, 1895. 20 pp. 8vo.

These bibliographies of three associated metals fill an important gap in chemical literature. That by Dr. Langmuir is reprinted from the School of Mines Quarterly (Vol. xv), at the request of your Committee. Both indexes are arranged chronologically and provided with author-indexes.

3. Bibliography of Aceto Acetic Ester. By Paul H. Seymour. Smithsonian Miscellaneous Collections, No. 970. Washington, 1894. 148 pp. 8vo.

This bibliography was compiled by the author under the direction of Prof. Albert B. Prescott, and by him submitted to the Committee who recommended its publication Aug. 22, 1892. It consists of a series of carefully prepared, critical abstracts of original papers arranged chronologically with author- and subject- indexes.

After issuing the twelfth Annual Report the attention of the Committee was directed to two contributions to the bibliography of chemical and pharmaceutical periodicals by Dr. Friedrich Hoffmann, editor of *Pharmaceutische Rundschau*, viz.:

4. Die Deutsch-sprachlichen pharmaceutischen Zeitschriften. Pharm. Rundschau, New York, Vol. xii, pp. 7–10 (Jan. 1894) and p. 28 (Feb. '94).

5. English-sprachliche pharmaceutische, chemische und botanische Zeitschriften Nord-Amerika's. Pharm. Rundschau, New York, Vol. xii, pp. 131–136 (June 1894).

Several chemists have made reports of progress:

Prof. Henry Trimble, of Philadelphia, states he continues to collect references to the literature of the Tannins with the expectation of further publication at no very distant date.

Prof. Arthur M. Comey reports that his Dictionary of Solubilities, Vol. I, is nearly all in type, and should appear early in the autumn.

Dr. Alfred Tuckerman expects to complete the MS. of his Index to the Mineral Waters of all Nations in a few months.

Prof. F. W. Clarke is making progress with a new edition of the Recalculation of the Atomic Weights.

Dr. H. Carrington Bolton reports having done much work on the supplement to his Bibliography of Chemistry, the MS. now comprising about 6500 titles.

Mr. C. LeRoy Parker, of The Columbian University, Washington, has undertaken an Index to the Literature of Attempts to Decompose Nitrogen.

Mr. George Estes Barton, of the same Institution is at work on a Bibliography of Glycerol; and Mr. George Baden Pfeiffer, also of The Columbian University, is engaged on a Bibliography of Picric Acid and the Nitrophenols.

At the request of the Smithsonian Institution Dr. H. Carrington Bolton has undertaken to edit a new edition of his "Catalogue of Scientific and Technical Periodicals, 1665–1882," published in 1885 in the Smithsonian Miscellaneous Collections. The new edition will bring down to date the old periodicals and include new ones established since 1882. The work is well under way.

Mr. W. D. Bigelow of the Chemical Division of the U. S. Department of Agriculture has completed the MS. of an Index to Methods for the Detection and Estimation of Fusel Oil in Distilled Liquors. The channel of publication has not been determined.

In a communication to the chairman, Professor W. Percy Wilkinson, of Melbourne, states he is engaged on an Œnological Bibliography, to include works relating to the vine, viticulture, wine-making, vine-diseases and wine-analysis, published in Germany, France, England, America, Italy, Portugal and Spain. He expects the bibliography to number 2000 titles and will give full details as to date, size, editions, etc. It is to be published by the Royal Society of Victoria.

Monsieur G. Fr. Jacques Boyer, Editor of the *Revue Scientifique*, Paris, announces the preparation of a Bibliography of Physical and Chemical Science; information as to its scope and period is lacking.

Those interested in the chemical applications of electricity should note the following:

"Elektrotechnische Bibliographie; monatliche Rundschau über . . . der Elektrotechnik. Von Georg Maas," Leipzig, 1893.

Also: "Leiner's Elektrotechnischer Katalog . . . von 1884 bis 1893." Leipzig, 1893. 8vo.

The following special bibliography has recently appeared in France: "Bibliographie de la technologie chimique des fibres textiles. Propriétés, blanchîment, teinture, matières colorantes, impression, apprêts. Par J. Garçon. Paris, 1893. 8vo." This work has been honored with a prize by the "Société industrielle de Mulhouse."

Although not pertaining to chemistry, we may briefly note the appearance of another special bibliography; "Bibliographie der psycho-physiologischen Litteratur des Jahres 1893. Hamburg, 1894. 8vo." Published in the Zeitschrift für die Psychologie und Physiologie der Sinnesorganen.

Attempts to establish a comprehensive Index to Chemical Literature in the form of a periodical are not altogether successful, lacking the

important element of permanence. The "Index" announced by Dr. Bechhold of Frankfort-on-Main, noticed in our Twelfth Report, has not made its appearance; the "Biblioteca Polytecnica" by Szczepanski ceased at the close of one year; the "Universal Index" by Wien and Brockhaus reached only nineteen numbers. Dr. J. Ephraim advertises the following: "Index der gesammten chemischen Litteratur (Wissenchaft und Technologie), Berlin," but no number has yet appeared.

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August, 1895.

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AND

ENGINEERING.

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ADDRESS

BY

WILLIAM KENT,

VICE PRESIDENT, SECTION D.

THE RELATION OF ENGINEERING TO ECONOMICS.

In the first page of Mr. J. R. McCullough's "Introductory Discourse" (published in 1828) to his edition of Dr. Adam Smith's great work, "An Inquiry into the Nature and Causes of the Wealth of Nations," he gives one of the best definitions we have of the science of political economy. "Its object," he says, "is to point out the means by which the industry of man may be rendered most productive of those necessaries, comforts and enjoyments which constitute wealth; to ascertain the proportion in which this wealth is divided among the different classes of the community. and the mode in which it may be most advantageously consumed."

The definition of engineering given by Tredgold. and incorporated into the charter of the British Institution of Civil Engineers, is "The art of directing the great sources of power in nature for the use and convenience of man." Rankine says: "The engineer is he who by art and science makes the mechanical properties of matter serve the ends of man."

Mr. George S. Morison, President of the American Society of Civil Engineers, in his address at the convention of the Society in June of this year, says:

"Every engineering work is built for a special ulterior end; it is a tool to accomplish some specific purpose. Engine is but another name for tool. The highest development of a tool is an engine which manufactures power."

Comparing the above definitions of political economy and of engineering, we find they are closely related. Political economy, according to McCullough, points out the means by which the industry of man may be rendered most productive of wealth. If we asked the merest tyro in knowledge of human industry by what means industry might be rendered most productive, he would naturally answer, "by the use of tools." The engineer is the tool builder. His best work is the building of an engine which manufactures power, makes industry most productive and manufactures commodities which are the elements of wealth. Political economy, which points out the means by which industry may be made most productive, should therefore point out tools and engines. But, strange to say, the writers on political economy have almost entirely neglected to point out these means. Their "dismal science," as it is called, generally points out everything but tools and engines. It treats of buying and selling, of supply and demand, of rents, interest and wages, of tariffs, of money and currency, of land values, taxes, and what not; but, with rare exceptions, does not mention engineering, which is the most potent force in economics of the nineteenth century.

Adam Smith, the first great English writer on political economy, writing in 1776, when he was, of course, not to be blamed for knowing nothing of the engineering of this century, said, "The greatest improvement in the productive power of labor, and the greater part of the skill, dexterity and judgment, with which it is anywhere directed or applied, seem to have been the effects of the division of labor." He gives a famous instance of division of labor in the manufacture of pins. One man, he said, might with difficulty make one pin a day, and certainly could not make twenty. But as the manufacture was carried on in his day, by division of labor one man draws out the wire, another straightens it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head, and so on, dividing the labor up among ten men, and eighteen different operations. Those ten men thus made between them 48,000 pins per day. Most writers on political economy have followed Adam Smith, and given division of labor the credit for making the greatest improvement in production, and neglected the still more important improvement, the introduction of machinery, by which the labor of the ten men was all done by a machine with one man tending it. But I find that Robert Ellis Thompson, in his

work on Political Economy (1875), mentions the case of the pin industry in its modern phase. He says: "An inventive mechanic has put together a machine that only needs to be fed with wire, well oiled and supplied with steam power, to turn out complete pins, sort them, and even thrust them into the papers in the right numbers and in straight rows."

The example of the pin industry may be taken as representative of what has taken place in every branch of productive industry. By the use of the steam engine and of other machinery the productive power of human labor has been increased a thousandfold, and engineering thus becomes the most important force which has caused an industrial and economic revolution throughout the civilized world, and the one subject of all others which should be discussed by a political economist.

Political economy being broadly the science of wealth, and since wealth is property, and property, according to some writers of the socialist school, is robbery, it may be well to get our bearings here, and see whether wealth is a thing to be desired or not. I quote here the words of Mr. McCullough in his "Introductory Discourse," above mentioned, and without further argument may say that I agree with him entirely. "The acquisition of wealth is not desirable merely as the means of procuring immediate and direct gratification, but as being indispensably necessary to the advancement of society in civilization and refinement. Without the tranquillity and leisure afforded by the possession of accumulated wealth, those speculative and elegant studies which expand and enlarge our views, purify our taste, and lift us higher in the scale of beings, can never be successfully prosecuted. It is certain, indeed, that the comparative barbarism and refinement of nations depend more upon the comparative amount of their wealth than on any other circumstance. It is impossible to name a single nation which has made any distinguished figure either in philosophy or the fine arts without having been at the same time celebrated for its wealth."

Having thus settled the question of the desirability of wealth, let us consider what is the engineer's share in its production. The great forces of nature which the engineer utilizes for the production of wealth are the forces of wind and of running water, and the stored energy of fuel in the forests, peat bogs, coal mines, and gas and oil wells. By far the greatest of these forms of stored energy is that of coal. Let us compare for a moment the work that can

be done by a ton of coal with the muscular power of men. One man digging coal from the side of a hill can easily dig two tons, say 4,000 lbs. of coal, in a day. Another man running a boiler and engine can burn these same two tons under a boiler, and if the engine is a moderately good non-condensing engine using three pounds of coal per indicated horse-power per hour, it will develop from the two tons of coal 133 horse-power for ten hours, equivalent to the physical labor that could be done by 1,300 men. Thus a man's labor by means of coal and a steam engine can be multiplied 650 times. But if we use a large high-grade triple-expansion, condensing engine, it will require only half as much coal per horse-power, and then if we set the engine to work to mine the coal itself, through the agency of mining machinery, and to feed its own coal to the boiler by means of automatic stokers we see that the effectiveness of man's labor can be still more vastly increased.

Let us consider some of the results which the engineer has been able to accomplish by the utilization of coal.

In my study of the subject of this address, while I have failed to find it properly treated in any of the standard works on political economy to which I have had access, I have found it discussed in a more or less fragmentary manner in writings and addresses of numerous engineers, statisticians and other specialists; and, since it is more convenient to quote largely from their writings than to write anything original, I will now trouble you with some quotations.

I first quote from a recent lecture by Mr. Edward Orton, State Geologist of Ohio, before the Ohio Mining Institute:

"All the great applications of the stored power of the world belong to the nineteenth century, and the most important of them belong to the last fifty years. What has been done within this century constitutes by far the most important chapter in the economic history of the race. Fossil power lies at the root and center of this unparalleled advance. In Great Britain alone coal does the work of more than 100,000,000 men. It adds to the wealth of these fortunate islands on this basis.

"The great powers, those that are making over the world, are steam and electricity. The steam engine lies at the bottom of by far the greatest industrial and economic revolution through which the race has ever passed, and steam is now being re-enforced by the new motor, from which we justly expect so much.

"There are no more distinctive features of our time than the two following: namely, the remarkable growth of cities throughout the civilized world and the unparalleled increase of the wealth of men. Both take their rise in coal; both are conditioned by its use in all their phases and stages. All modern manufactures are absolutely dependent on the stored force of coal. Machinery driven by this power is everywhere replacing the skilled labor of the olden time. Cities grow largely by massing the ruder labor that our modern factories can utilize.

"With this growth of cities in the modern world, a group of problems arises, all of which are new and of which we are obliged to work out the solutions. No other problems of equal gravity and urgency confront the statesman, philosopher or philanthropist of our day. All of them have their root in coal."

Mr. John Birkinbine, past president of the American Institute of Mining Engineers, estimates that if only 1% of the consumption of fuel of all kinds in the United States, including coal, wood, oil and gas, were saved, it would be equal to 2,300,000 tons of coal per year. It is the work of the engineer to devise ways and means to accomplish this saving, and more.

Mr. Chas. H. Loring, past president of the American Society of Mechanical Engineers, in his presidential address in 1892, thus spoke of the influence of the steam engine upon civilization:

"The civilizations of antiquity were limited to a few cities, and were based upon slave labor, the slaves being drained from other places, which were thus doomed to deepening barbarism.

"The disgrace of the ancient civilization was its utter want of humanity. Justice, benevolence and mercy held but little sway; force, fraud and cruelty supplanted them. Nor could anything better be expected of an organization based upon the worst system of slavery that ever shocked the sensibilities of man. As long as human slavery was the origin and support of civilization, the latter had to be brutal, for the stream could not rise higher than its source. Such a civilization, after a rapid culmination, had to decay, and history, though vague, shows its lapse into a barbarism as dark as that from which it had emerged.

"Modern civilization also has at its base a toiling slave, but one differing widely from his predecessor of the ancients. He is without nerves and he does not know fatigue. There is no intermission in his work, and he performs in a small compass more than the

labor of nations of human slaves. He is not only vastly stronger, but vastly cheaper than they. He works interminably, and he works at everything; from the finest to the coarsest he is equally applicable. He produces all things in such abundance that man, relieved from the greater part of his servile toil, realizes for the first time his title of Lord of Creation. The products of all the great arts of our civilization, the use of cheap and rapid transportation on land and water, and of printing, density of population everywhere, the instruments of peace and war, the acquisition of knowledge of all kinds, are made the possibility and the possession of all by the labor of this obedient slave, which we call Steam Engine.

"We who were born under this benign influence but vaguely appreciate its value, and rarely recognize our obligations to it; existing civilizations would be impossible without it, and if human ingenuity finds no substitute for it they will perish with it.

"The steam engine is a machine which has been the prolific parent of other machines. It has caused the invention and construction of the immense plant of ingenious power tools employed in its own fabrication; it has caused the improvement of metallurgy as a science and of the various methods of metal manufacture as an art; it may be said to have created whole branches of important manufacture, and to have been the occasion of the invention of the immense mass of highly-diversified machinery, by means of which these manufactures are practised; and, last and greatest, it has stimulated and directed the human intellect as nothing else ever has, and has done more to advance human nature to a higher plane than all which statesmen, generals, monarchs, philosophers, priests and artists have ever accomplished in the vast interval which separates original man from the man of to-day. It has raised man from an animal to something approaching what a great intelligence should be, by simply placing in his hands a limitless physical power capable of application in every conceivable direction and to every conceivable purpose."

The value of the invention of Bessemer steel to the human race is discussed as follows in an address by Mr. Abram S. Hewitt in 1890 ("Trans. Amer. Inst. Mining Engineers," Vol. XIX, p. 518):

"The Bessemer invention takes its rank with the great events which have changed the face of society since the Middle Ages. The

invention of printing, the construction of the magnetic compass, the discovery of America and the introduction of the steam engine are the only capital events in modern history which belong to the same category as the Bessemer process. They are all examples of the law of progress, which evolves moral and social results from material development. The face of society has been transformed by these discoveries and inventions.

"Steel is now produced at a cost less than that of common iron. This has led to an enormous extension in its use and to a great reduction in the cost of the machinery which carries on the operations of society. The effect has been most marked in three particulars: First, the cost of constructing railways has been so greatly lessened as to permit of their extension into sparsely-inhabited regions, and the consequent occupation of distant territory otherwise beyond the reach of settlement; second, the cost of transportation has been reduced to so low a point as to bring into the markets of the world crude products which formerly would not bear removal, and were thus excluded from the exchanges of commerce; third, the practical result of these two causes has been to reduce the value of food products throughout the civilized world, and, inasmuch as cheap food is the basis of all industrial development and the necessary condition for the amelioration of humanity, the present generation has witnessed a general rise in the wages of labor, accompanied by a fall in price of the food which it consumes. . . . . These are material results, but they are accompanied with the slow but sure elevation of the great mass of society to a higher plane of intelligence and aspiration."

The increase of working power of the United States is thus shown by Mr. M. G. Mulhall, the great statistician, in the "North American Review" for June, 1895. The working power of an able-bodied male adult is 300 foot-tons daily; that of a horse, 3,000, and of steam horse-power, 4,000. On this basis the working power of the United States was at various dates approximately as follows, in millions of foot-tons daily:

Year.	Hand.	Horse.	Steam.	Total.	Foot tons daily per inh'b'nt.
1820	753	3,300	240	4,293	446
1840	1,406	12,900	3,040	17,346	1,020
1860	2,805	22,200	14,000	39,005	1,240
1880	4,450	36,600	36,340	77,390	1,545

Year.	Hand.	Horse.	Steam.	Total.	Foot tons daily per inh'b'nt.
1895	6,400	55,200	67,700	129,300	1,940
Gt. Britain, 1895 .	3,210	6,100	46,800	56,110	1,470
Germany, 1895 .	4,280	11,500	29,800	45,580	902
France, 1895 .	3,380	9,600	21,600	34,580	910
Austria, 1895	3,410	9,900	9,200	22,510	560

Notice from this table how vastly the power of man is increased by the use of the steam engine, and in the United States how great was the increase in the last fifteen years.

"The wealth of the American people," says Mr. Mulhall, "surpasses that of any other nation past or present. The physical and mechanical power, which has enabled a community of wood cutters and farmers to become, in less than 100 years, the greatest nation in the world, is the aggregate of the strong arms of men and women, aided by horse-power, machinery and steam power applied to the useful arts and services of every-day life." "The accumulation of wealth in the United States averages $7,000,000 daily."

The increase of wealth in the United States is shown as follows, according to Mulhall:

Year.	Total of wealth, millions of dollars.	Wealth per capita.
1820	1,960	$205
1840	3,910	230
1860	16,160	514
1880	43,642	870
1890	65,037	1,039

Wealth per capita in different countries in 1890:

Great Britain	$1,260
France	1,130
Holland	1,089
United States	1,039
Belgium	840
Germany	780
Sweden	639
Italy	480
Austria	475

Average yearly wages per operative in the United States:

1860	$289
1870	302
1880	347
1890	485

Rural or agricultural wealth in the United States has quadrupled in forty years, while urban wealth has multiplied sixteen-fold.

	Millions of dollars.			Per cent of total.	
	Urban.	Rural.	Total.	Urban.	Rural.
1850	3,169	3,965	7,136	44.4	55.6
1860	8,180	7,980	16,160	50.6	49.4
1870	15,155	8,900	24,055	63.0	37.0
1880	31,538	12,104	43,642	72.2	27.8
1890	49,065	15,982	65,037	75.4	24.6

During the last twenty years the increment of rural wealth has been almost uniform at $47 per head per annum of the number of rural workers. In urban workers the accumulation averaged $83 per annum, which suffices to explain the influx of population into towns and cities.

The increased productiveness of the farmer, due to his use of machinery, is shown as follows: "An ordinary farmhand in the United States raises as much grain as three in England, four in France, five in Germany and six in Austria, which shows what an enormous waste of labor occurs in Europe because farmers are not possessed of the same mechanical appliances as in the United States."

"In the United States one man can feed 250, whereas in Europe one man feeds only 30 persons. Nor can we hope for a better state of things in Europe soon. So dense is the ignorance of most men, even among the educated classes, that they are convinced that all labor-saving appliances are an evil, and that the more persons there are employed to do any given work the better."

During a visit to Germany three months ago I learned of an instance of this ignorance among the laboring classes. My travelling companion saw three men cutting grass on a lawn with ordinary scythes and sickles. "Why don't you use a lawn mower?" said he, "then one man could do as much as three are now doing." "Don't talk to us about lawn mowers!" said one of the men, "it is all we can do now to find work enough to earn our bread. If we had a lawn mower two of us would starve." They did not think that if their employer saved the wages of two men, the money would burn a hole in his pocket until he either employed it for some useful purpose, by giving employment to either the same two men or two others, or loaned it to some one who would employ it.

In the United States, however, the old-time opposition to the introduction of labor-saving machinery as a harm to the laboring man, throwing him out of employment, has now almost died out among reasoning men, and it is generally acknowledged by men who have studied the subject that the steam engine and labor-saving machinery in general are the chief agents of the civilization of the latter half of the nineteenth century, and that they have increased the productiveness of man's labor, increased his wages, shortened his hours of labor, cheapened his food and clothing and given the average man comforts and luxuries which a century ago not even kings could have commanded.

Mulhall's "Dictionary of Statistics" (1892) gives the following facts concerning the agriculture of the world. Capital and product have more than doubled since 1840, but the number of hands has not risen 50%.

Agricultural capital of the world, millions of dollars.

	Land.	Cattle.	Sundries.	Total.
1840	35,475	4,970	4,735	45,180
1860	59,310	7,810	7,495	74,615
1887	88,880	13,505	12,645	115,030

Agricultural capital of the United States, millions of dollars.

	Land.	Cattle.	Sundries.	Total.
1840	2,000	480	500	2,980
1860	6,910	1,130	1,185	9,225
1887	12,800	2,505	3,175	18,480

In the United States 9,000,000 hands raise nearly half as much grain as 66,000,000 hands in Europe. Thus it appears that for want of implements and of proper machinery there is a waste of labor in Europe equal to 48,000,000 of peasants.

The census returns of manufactures of the United States, 1880 and 1890, show the following:

	1880.	1890.	Increase per cent.
No. of establishments reporting	253,502	322,624	27.27
Capital	$2.780,766,895	$6,138,716,604	120.76
Av. No. of employees	2,700,732	4,476,094	65.74
Total wages	$939,462,252	$2,171,356,919	131.13
Cost of materials used	3,395,925,123	5,018,277,603	47.77
Value of products	5,349,191,458	9,054,191,458	69.27

Vast economic changes throughout the world have recently taken place as the result of the development of engineering. Mr. Edgerton R. Williams, in his article on "Thirty Years in the Grain Trade" ("North American Review," July, 1895), says:

"In 1869, 97% of England's population, say, 18½ out of 19 millions, were fed on English-grown wheat. In 1890, with a population of 25 millions, only 5 millions were supplied with English wheat, a falling off of 77%. The decrease in wheat acreage in 40 years, from 1846 to 1886, was nearly 66%."

The tendency of population from the country to the cities is a consequence of the increased production of manufactures and of the decrease in the percentage of the total population required to produce the food of the world. This tendency in the United States is shown in the following census figures:

	Urban population. per cent of total.				
United States	1850	1860	1870	1880	1890
Per cent	12.49	16.13	20.93	22 57	29.12

In the northern central division of the United States, in the past ten years, the urban element has nearly doubled, while the total population has increased only 25.78%. The increase in urban population is confined mainly to a few large cities.

The completion of the Trans-Siberian Railroad, and the extension of railroads in India and in the Argentine Republic will probably before long make Europe independent of the grain crop of America. Mr. Worthington C. Ford, Chief of the United States Bureau of Statistics, in the "North American Review" for August, says: "It is now the Argentine Republic which appears to have an almost unlimited power to grow and export wheat in defiance of any competition." The perfection of refrigerating machines—an engineering triumph—makes it now possible for Europe to receive its supply of meat from Australia and from the Argentine Republic, as well as from the United States. The introduction of modern cotton machinery into Japan and into India threatens the cotton trade of England with exclusion from the markets of Asia, one of England's greatest present resources. In Australia, according to Mr. Ford, the ranchmen are successfully overcoming one of the most serious obstacles to the extension of sheep raising, by sinking artesian wells and making pools or dams to retain the water for their stock—another example of the application of engineering in

using nature's stored forces to overcome the resistance of nature. There thus appears to be no limit to the economic changes throughout the world which may yet be made by the use of engineering appliances.

"Marked economic effects have attended the building, or failing to build, important highways in the United States of whatever kind where opportunity and need existed. The early topographical engineers of the country, including especially George Washington, who was an engineer by profession, foresaw that at whatever point on the Atlantic coast an outlet should be made for the products of the Ohio and Mississippi valleys, a great, probably the greatest, seaport would arise. Virginia was at this time far in advance of the other states, and especially of New York. . . . Washington urged the legislature of Virginia to build a canal connecting the Ohio River and the James or Potomac, so as to place the outlet at Norfolk. His advice was not heeded. Subsequently New York, under the leadership of De Witt Clinton, constructed the Erie Canal, connecting Lake Erie, at Buffalo, with the Hudson, at Albany, then a stupendous feat of state enterprise in finance and civil engineering. Until that canal was built New York city had little more than the trade of the Hudson River valley. The building of the canal made New York the Empire state and the city the commercial metropolis of the Union."—Denslow, p. 150.

Who can estimate the economic value to the United States of that great feat of engineering, the building of the first railroad across the continent? What an increase of the wealth of nations has flowed from the opening of the Suez Canal, and what another increase will follow the completion of the Nicaragua Canal!

Improvements in engineering methods often cause the destruction of vast amounts of fixed capital by the substitution of new appliances for the old. "The British government expended in 1864–'70 £20,000,000 on a class of armored gunboats, which, before any use was made of them, were condemned as worthless, owing to the improvements in the construction of guns. It expended large sums on iron guns, which became useless by the substitution of steel guns, etc. A telegraph company expended large sums of money in constructing a line through Siberia and Alaska, whereby to get telegraphic communication between New York and London, via San Francisco and Behring Straits, which was made totally worthless by the laying of the first Atlantic cable" (Denslow, p. 81).

Numerous canals and canal boats have been thrown out of use and allowed to fall into decay on account of the competition of railroads.

Between 1872 and 1880 a revolution took place in the construction and in the method of driving blast furnaces for making iron, so that, of 700 blast furnaces running or in condition to run in 1872, probably not 50 are now on the active list, and although the production of iron has more than quadrupled since that date, only 480 furnaces are now on the list of existing furnaces, and more than half of these are out of blast. The destruction of capital involved in the abandonment of old furnaces is probably over $100,000,000. A similar destruction of fixed capital has followed the substitution of Bessemer steel for puddled iron, and in the introduction of improved forms of rolling mills. A great decrease in the value of the iron mines of New Jersey, New York and Pennsylvania has followed the opening of better mines in Lake Superior.

One of the great achievements of engineering is the substitution of the factory system of labor for the old domestic system. The beginning of the factory system was in the decade of 1760–1770, when the spinning jenny, the spinning frame and the spinning mule were introduced into the textile industry, but it did not begin its full career of development until after Watt had perfected his steam engine, about thirty years later. Has the factory system been a benefit to civilization? There is no better authority on this question than Mr. Carroll D. Wright, formerly United States Commissioner of labor, and now Commissioner of the Census of 1890. He says ("Johnson's Cyclopædia," Vol. III. p. 265): "The factory system is in every respect vastly superior to the domestic system as an element of civilization, although this is contrary to popular impression and largely against popular sentiment. . . . Under the domestic system the home of the worker was the workshop also, and the wheels or looms disputed with the inmates for the room and the conveniences for housework. Small, close, crowded, with bad air and bad surroundings, the hut of the domestic worker was occupied by a class which had not found, and cannot find, its like under the factory system; for, as a rule, the operative of to-day occupies a home even in the factory tenement or boarding house, superior in every sense to the home of the domestic worker.

"Under the domestic system of industry grew up that great pauper class in Great Britain, which was a disgrace to civilization. It

continued to grow, until one-fourth of the annual budget was for the support of paupers. . . . The domestic laborer's home was far from having the character poetry has given it. Huddled together in what poetry calls a cottage and history a hut, the weaver's family lived and worked, without comfort, conveniences, good food, good air, and without much intelligence. Drunkenness and theft of materials made many a house the scene of crime and want and disorder. Superstition ruled, and envy swayed the workers. Ignorance under the old system added to the squalor of the homes of the workers under it, even making the hut an actual den, shared in too many instances by the swine of the family. The home of the agricultural laborer was not much better: in fact, in Great Britain and France he has to a great degree continued in his ignorance and in his degraded condition."

"One of the positive results of the factory system has been to enable men to secure a livelihood in fewer hours than of old. This means intellectual advancement, for, as the time required to earn a living grows shorter, civilization progresses. . . . The fact that the lowest grade of operative can now be employed in factories does not signify more ignorance, but a raising of the lowest to higher employments. This process is constantly narrowing the limits of the class which occupies the lowest step in the progress of society. This mission alone stamps the system as an active element in the moral elevation of the race. The factory system does not tend to intellectual degeneracy."

The arguments thus far adduced have all been one-sided in showing that an increase in civilization and in refinement follows an increase in wealth. There is another side to the question. A portion of the laboring masses is dissatisfied. This side is ably treated, in the August issue of the "North American Review," by Rev. J. A. Zahm, C. S. C., entitled "Leo XIII and the School Question." I quote as follows:

"In lieu of the old organic régime the French Revolution substituted the reign of individualism. Unlimited competition, freedom of labor, the preponderance of capital and the general introduction of machinery ushered into existence the fourth estate proletarians, or wage-earners—and with it the social question. The organism became a mechanism, and from its excesses proceeded the evils from which we now suffer. As matters at present stand, we have two inimical forces, standing face to face: on one side,

the modern state with its army and its police; on the other, socialism and organized labor with its battalions and its long pent-up grievances.

"Never before was humanity confronted with such a danger. Three centuries of renaissance of pagan law and a century of *laissez-faire* and *laissez-passer* have atomized society and divided the human family into two opposing camps; on one side the tyranny of the law and of the employer, on the other, renewed servitude and virtual rebellion—everywhere hatred, lack of equilibrium, egotism and overt struggle.

"Formerly, after the struggle between employer and employee was over, rest and peace were to be found in the workshop or in the home, whereas to-day the struggle has reached our very hearthstones. It persists in a dull and sullen manner, when it does not break forth openly, and it is ever compassing the ruin of society because it is incessantly destroying all chance of domestic happiness. Never before, indeed, has the social question knocked in so threatening a manner at the doors of the civil order."

Mr. Zahm charges machinery, which is engineering, with being one of the chief causes of social troubles. He says further:

"It may truly be said that the social question arises from a five-fold revolution: the revolution in machinery; the revolution in political economy; the revolution in religion; the revolution in the state, and the revolution brought about by the general movement of humanity.

Machinery, or rather the abuse of machinery, was the first to effect a transformation in the economic order. It is not without reason that Lassalle styles it "the revolution incarnate"—*Die verkoerperte Revolution.* Machinery has revolutionized the mode of production, the manner of labor, and the distribution of revenue and of property. It has destroyed the workshop and introduced the factory in its stead. It has sterilized manual labor, and, by its immense productivity, has internationalized prices and markets. While, on the one hand, it has created the despotism of capital, it has, on the other, called into existence the unorganized army of the proletariate. It has ground humanity into a powder, without cohesion and without unity, and has placed the world of labor at the mercy of a few soulless plutocrats. This new order of things means the reign of the few; it implies the permanence of expropriation and the resurrection of ancient Rome, where millions of

slaves were trampled under foot by an insolent oligarchy of wealth; and, finally, by its fatal centralization machinery has engendered a double International—the International of capital and the International of socialism. Never has a more complicated situation, or one more pregnant with peril, weighed upon men. What were the invasions of the barbarians from the north of Europe, or the upheavals of the fifteenth and eighteenth centuries, in comparison with the threatened explosion of this vast world already stirred to its profoundest depths and in a state of violent ebullition?"

The remedy for this terrible state of affairs, according to Mr. Zahm, is to be found in following the advice given in the recent encyclical letter of the Pope. I quote:

"In the introduction to his epoch-making document, Leo XIII directs attention to some of the evidences of the dominant evil—extreme riches, extreme misery, and the indescribable desolation which has entered the world of the proletariate in consequence of the atomization of society under the levelling reign of capital.

"As in the Politico-religious order, Leo XIII has, through his encyclical 'Immortale Dei,' preached the code of reconciliation, so has he, in the economic order, promulgated the charter of social harmony. For the first time economic science has pity on the wage-earner, and discusses the new issues raised without rancor or recrimination. At the same time it exhibits a respect for the rights of all while insisting on the duties of all, which will forever render the encyclical 'Rerum Novarum,' not only the most glorious monument of the present pontificate, but also the most beneficent contribution yet made to the new order of things."

We must give all honor to Pope Leo XIII for his earnest efforts to bring about social harmony, but Mr. Zahm is surely not right in saying that this is the first time that economic science has pity for the wage-earner. Many writers in all schools—Henry George, for example—have been animated by sincere sympathy for the wage-earner, and have earnestly discussed means of ameliorating his condition. I hope to show in my conclusion that the whole tendency of economic evolution is toward bettering the condition of the wage-earner.

Mr. Hewitt, in his presidential address before the American Institute of Mining Engineers in 1890, entitled "Iron and Labor," "Trans. A. I. M. E.," Vol. XIX, pp. 496, 497, speaks of "the new era, when every intelligent workman will insist on being an owner,

and every well-managed corporation will see that its workmen are directly interested in the results of the business." He says: "The time is approaching when capitalists and laborers will more and more be joint owners in the instruments of production. While the wages system will necessarily survive, the workmen will, to a large extent, become their own employers, and finally may hire capital as capital now hires labor. The facilities offered for the division of property, through the distribution of corporate shares, will lessen strife, develop skill, reduce cost, increase production and promote the equitable distribution of wealth, which, it must never be forgotten, is the chief end of the social organization."

The equitable distribution of wealth which Mr. Hewitt speaks of is the aim of all honest political economists of all schools. They only differ as to the means through which it is to be brought about, and they differ vastly in their apprehension of what is the existing state of things. The chief difficulty of the socialist writers, and of such men as Henry George and Mr. Zahm, is that they do not see clearly the existing facts. Seeing the vast wealth of a few individuals, they preach the dictum the "rich are growing richer and the poor are growing poorer," the last half of which is a stupendous economic falsehood, equalled only by the dictum of the anarchists that "property is robbery." Innumerable facts can be adduced to show that the statement that the poor are growing poorer is a falsehood. Statistics prove beyond all question that in all the civilized world the wages of labor have tended, ever since the extensive use of the steam engine, say, since 1850, to increase, and the cost of living to decrease. Statistics of savings banks, of building associations, of life insurance companies, of fraternal assessment life insurance associations, of the ownership of small houses and small farms, of the reduction of mortgages on farms,—all show that not only is there a vast increase in the wealth of the nation as a whole, but that this wealth is being more widely distributed than ever before. A magazine article recently said that more than one-half of the entire population of New England, including men, women and children, are depositors in the savings banks, the average amount to the credit of a depositor being $363. It says of the depositors: "If it were possible to prove what is apparent to the eye of any one who watches the customers of these banks, it would be found that very much the largest part of them are the women and children. The aggregate of deposits in the savings banks in New England is $774,000,000. In New York state alone it is $644,000,000."

In the little town in which I live, Passaic, N. J., containing 18,000 inhabitants, a considerable part of the population are Poles, Bohemians, Hungarians and other natives of southern Europe. They are recent immigrants, working in mills; yet one of the two savings banks in the city has 2,500 depositors, the deposits amounting to nearly $400,000 and, in addition, the same foreigners last year sent to Europe, in the shape of drafts issued by this same bank, not less than $50,000.

Place the statements just made concerning savings banks against those made by Mr. Zahm, viz., that the human family is divided into two opposing camps; that we have two inimical forces standing face to face, on one side the modern state with its army and its police; on the other socialism and organized labor. How can we reconcile these two apparently conflicting views of the existing status? Why, very easily. Mr. Zahm's two opposing camps exist: on one side the socialists, on the other the police; but his eyes were blinded when he said that the whole human family is divided into two opposing camps. He failed to see the vast majority of the people who belong neither to one camp nor to the other, who are the savings bank depositors, the owners of small homes, albeit with small mortgages on them, who are members of building associations and fraternal life insurance societies. The grandest fact in the economic history of this age is the great increase in the number of the people in comfortable circumstances who once were numbered among the poor. This increase in the middle class goes along with a great decrease in the number of the very poor. The poor are growing poorer, say the agitators. Whom do you mean by the poor? Is it a family that has only $100 in the savings bank? Next year it will have $200 and five years hence $1,000.

Do you mean then, we ask the agitator, the man who has not a dollar in any bank, who has not enough ahead to keep him from starvation a week. If he is the man whom you call poor, and of whom you have been saying for the last twenty years that he is growing poorer, how much poorer is he going to get? How many such men are there in the United States? Let them stand up and be counted.

We have seen that engineering is the chief factor in the production of wealth; that wealth has enormously increased in the past few years, and that it is being well distributed, although perhaps not as well as it ought to be among the common people. What of the future? Engineering has caused men to leave the

farm and seek the cities, because in the cities they can grow rich faster. Engineering again, through rapid transit, electric cars and the like, is making it possible for these men who work in the city to sleep in the suburbs, and bring up their families in a place which has all the advantages of city and country combined. One of the triumphs of the iron-making engineer has been the construction of a hollow steel tube of great lightness and strength. The mechanical engineer has found out how to make ball bearings, and lo! we have the bicycle of 1895, 400,000 of them to be made in this year. Who can estimate the value to the people of this new industry, building up an athletic and healthy race of men and women, and causing good roads to be built from one end of the country to the other, another work of engineering, by which the farmer may move his crops more cheaply and the cost of food be correspondingly decreased. What next? As Mr. Hewitt has foreseen, the wage-earner will become a stockholder in the corporations for which he works, and labor will hire capital, instead of capital hiring labor. Then what Mr. Zahm calls the fourth estate, the proletariat, will cease to exist. It will be merged into the third estate, the common people, who are at the same time wage-earners and capitalists. The proletariat, or fourth estate, as a separate element in society, antagonistic to the third estate, is already a vanishing quantity. We who are old enough remember the alarm created throughout the world in the years 1867, 1868 and 1869 when the dreaded "International" held its congresses in Europe. Who now dreads the International? True, it may be strong enough some day in some one or more places to repeat the terror of the Paris Commune of 1870, but the uprising will end as the uprising of the Commune did, and it will not take two months to end it, as it then did.

"The Empire is peace," said Napoleon III, just before the Franco-Prussian War. He was mistaken. The war took place, causing vast loss and suffering, followed by the terrible agony of the Commune. But how nobly France recovered from the shock, how quickly she paid the indemnity to Germany out of the actually stored savings of her common people! No revolution in the social order took place, only a change in government—then everything went on as before. So it will be if the International should arise, as is predicted by the alarmists, and reproduce the horrors of the French Revolution. The world will live through it; the social

order, as of old, will be restored, and the present relations of capital and labor will not be changed, except as by gradual and necessary evolution, due to engineering more largely than to any other one cause, capital and labor become merged by the laborers becoming capitalists. This will be the crowning triumph of engineering, by which the increase of wealth is caused, and which enables the laborer to become a capitalist. Then the political economists may meet together and discuss the improved social order, burn their old books, and erect a monument to the man who, above all others, contributed the means for obtaining the wealth of nations,— James Watt, the engineer.

PAPERS READ.

ON THE DESIGN OF FISH-PLATE TIMBER JOINTS. By Prof. HENRY S. JACOBY, Ithaca, N. Y.

[ABSTRACT.]

THE following formula is deduced, giving the resultant pressure of the side of a round bolt or pin against the wood, in the direction of the fibers,

$$P' = a\,d\,l\,S'$$

in which $a = \frac{S''}{S'}\left(1 + \log_e \frac{S'}{S''}\right)$, d = diameter of bolt or pin, l = length of bolt pressing against the timber, S' = maximum unit pressure in the direction of the fibers, and S'' = maximum unit pressure in a direction normal to the fibers.

The corresponding formula for the resultant pressure perpendicular to the direction of the fibers is

$$P'' = c\,d\,l\,S'$$

when $c = \left(1 - \cos\theta'\right) + \frac{S''}{S'}\,arc\left(90^\circ - \theta'\right)$, θ' being found from $\sin\theta' = \frac{S''}{S'}$.

When these formulas are applied to yellow pine timber with safe unit compressive stresses of $S = 1100$ and $S'' = 300$ pounds per square inch, θ' is found to be $15^\circ\ 50'$ and $a = 0.627$, while by experiment, the average value of a was found to be 0.60.

The force tending to split the timber when the resultant pressure of the bolt is in the direction of the fibers is $\frac{P''}{2} = 0.2\,d\,l\,S' = \frac{1}{3}P'$, and this must be provided for either by transverse bolts or by increasing the longitudinal distances between the bolts and from the bolts to the end of the timber beyond those required to provide the necessary shearing surface.

MATHEMATICAL THEORY OF THE WINDMILL. By Prof. DE VOLSON WOOD, Hoboken, N. J.

[ABSTRACT.]

THE pneumatic energy exerted by the wind upon a sail per second is found to be

$$V = \frac{\vartheta S}{g} c^2 v \left(\sin a - \frac{v}{c} \cos a \right) \sin a \cos a$$

and for the best effect a must be found from the equation

$$\tan^3 a - \frac{2v}{c} \tan^2 a - 2 \tan a + \frac{v}{c} = 0$$

These results differ from those given in Wolff on Windmills.

In the above, ϑ = weight of a cubic foot of air (about 0.08) at the level of the sea at ordinary conditions; S = area of sail in square feet; g = 32.2 feet; c = velocity of the wind in feet per second; v = velocity of the sail in feet per second; and a = the inclination of the sail to the direction of the wind.

ON PARTIALLY CONTINUOUS DRAWBRIDGE TRUSSES WITH A METHOD OF DEDUCING FORMULAS FOR THE REACTIONS. By Prof. MANSFIELD MERRIMAN, South Bethlehem, Pa.

[This paper is published in full in the Engineering News of Sept. 5, 1895, and in the Railroad Gazette of Sept. 6, 1895.]

THE PERFECT SCREW PROBLEM. ILLUSTRATED BY A COMBINED RULING ENGINE AND COMPARATOR IN AUTOMATIC OPERATION. By Prof. WILLIAM A. ROGERS, Waterville, Me.

EXPERIMENTS ON THE FLOW OF STEAM, AND COMPARISON OF THE RESULTS WITH NAPIER'S FORMULA. By JOHN J. FLATHER, Lafayette, Ind.

THE ECONOMICS OF ENGINEERING PUBLIC WORKS. By HENRY N. OGDEN, Ithaca, N. Y.

SECTION E.

GEOLOGY AND GEOGRAPHY.

OFFICERS OF SECTION E.

Vice President.

JED. HOTCHKISS, Staunton, Va.

Until the Vice President elect arrived on Monday, C. H. HITCHCOCK acted as Vice President *pro tempore.*

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J. PERRIN SMITH, Palo Alto, Cal.

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Sectional Committee.

JED. HOTCHKISS, *Vice President*, 1895, J. PERRIN SMITH, *Secretary*, 1895, SAMUEL CALVIN, *Vice President*, 1894, J. HOTCHKISS, *Secretary*, 1894. R. P. WHITFIELD, ARTHUR HOLLICK, C. H. HITCHCOCK.

Member of Nominating Committee.

WILLIAM H. RICE.

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Vice President and Secretary and EDWARD ORTON, R. P. WHITFIELD, W. M. DAVIS.

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E. O. HOVEY.

PAPERS READ.

GOTHAM'S CAVE; OR FRACTURED ROCKS IN NORTHERN VERMONT. By Prof., C. H. HITCHCOCK, Hanover, N. H.

[ABSTRACT.]

UPON the west side of Norris hill in Maidstone, Vt., is a series of openings or caves in mica schist rock, which may properly receive the name of the proprietor of the land. The locality has been known to me since 1880, but was not explored till 1893, when two members of the class of 1893, Dartmouth College, E. S. Miller and W. A. Redinbaugh, examined it thoroughly and prepared a thesis upon it. I visited it later and verified their statements.

The openings seem to be clefts in the rock, slightly analogous to the "flumes" of the White Mountains, but not produced like them by erosion. There are properly three sets of these chambers. Usually they are three feet wide. One is a hundred feet long beneath a cave, and the bottom is very uneven so that ladders are needed in explorations. Late in June ice was abundant in them. In the second set, one chamber measures twenty-two feet east and west; sixteen feet north and south. Several of the chambers may be regarded as cross fractures, whose walls match each other, but the south side is invariably a foot or more lower than the north wall. Viewed lengthwise the openings occupy three hundred feet and extend vertically one hundred feet. About six hundred feet below the steeper slope, towards Maidstone lake, there is a cold spring, giving rise to a flow of water six inches in diameter. And as the fractures may be traced somewhat further up the hill back of the chief exposures, it is safe to say that the whole line of fractures is about one thousand feet in extent.

As these openings are but partially filled, it seems probable that the force of elevation originating them has operated since the Ice Age.

RECENT DISCOVERY OF THE OCCURRENCE OF MARINE CRETACEOUS STRATA ON LONG ISLAND. By ARTHUR HOLLICK.

[ABSTRACT.]

THE development of our knowledge in regard to the extension of the Cretaceous formation eastward from New Jersey, has consisted of a series of discoveries, theoretically predicted as a whole, but often unexpected and puzzling as to details.

The presence of strata belonging to the so-called non-marine or plastic clay series was demonstrated some years ago for Staten Island,[1] Long Island[2] and Martha's Vineyard,[3] by the discovery of characteristic fossil leaves at Kreischerville, Tottenville, Princes Bay and Arrochar on Staten Island; Glen Cove, Sea Cliff, Lloyd's Neck and Eaton's Neck, on Long Island and Gay Head on Martha's Vineyard. Scattered through the moraine also, from Brooklyn to Montauk Point, wherever careful search has been made, fragments of ferruginous shale or sandstone, containing impressions of cretaceous leaves, have been found. The discovery of this material at the extreme end of Montauk Point was made last summer by the writer and has not been previously recorded.

The evidence of any marine cretaceous was, however, much less abundant. Staten Island[4] and Martha's Vineyard[5] had yielded a few molluscs characteristic of the marl beds, but nothing authentic had been discovered on Long Island,[6] and the absence of any indications of such material is more or less puzzling. Last summer, while exploring the north shore of Long Island, however, lithologic indications of marl strata were found on Center Island; but, as usual in that region, they were so distorted by glacial action as to be almost useless for stratigraphic calculations. Little more than the position on the map could be noted, and the absence of any palæontologic evidence was discouraging. Shortly afterwards, I accidentally heard that the Brooklyn Institute possessed some fragments of a drift bowlder which were said to contain cretaceous molluscs. Upon inquiry, the material, with all the facts connected with it, was placed at my disposal. It was evidently hardened marl, in which the iron salts had become oxidized, containing *Ostrea larva*, *Gryphea* sp., etc., and was found in the moraine at the site of the Ridgewood reservoir, Brooklyn. About the same time I also found somewhat similar material, containing fragmentary molluscs, at the end of Montauk Point. This latter was submitted to Prof. R. P. Whitfield, in the hope that something definite might be identified in it, but the fossils were too imperfect for determination.

Such are the facts, and the conclusions to be drawn from them are not entirely satisfactory.

At not one of the localities mentioned can we say that this cretaceous material is in place. Throughout the moraine it exists simply as drift material, while at other localities where clay or marl strata are exposed, these bear every evidence of having been displaced and shifted *en masse* by the shove of the ice front.

One thing is plain, however: where cretaceous material is now found in connection with the moraine, it must have existed originally, farther to

[1] Hollick, A., Trans. N. Y. Acad. Sci., xi (1892), 96-104.
[2] Hollick, A., Trans. N. Y. Acad. Sci., xii (1893), 222-237.
[3] White, David, Am. Journ. Sci., xxxix (1890), 93-101.
[4] Hollick, A., *l. c.*
[5] Shaler, N. S., Bull. Mus. Comp. Zool., xvi (1889), 89-97.
[6] Mention should be made of the alleged discovery of an *Exogyra*, sixty feet below the surface, in the moraine at Brooklyn. (Redfield, W. C., Abstr. Proc. 4th session, Assoc. Am. Geol. and Nat. in Am. Journ. Sci., xlv (1843), 156.

the north than where we now find it. Such being the case, it is more or less of a surprise to know that the marl belt must have curved northward, almost, if not quite, as far as to the East River, in which case the clay belt could only have been represented by a very narrow strip at about this point.

Another fact which appears to be difficult of explanation at first sight, is that if the marl is present at Center Island it is north of the clay in Northport harbor, which latter has been shown to be undoubtedly cretaceous.[1] This isolated patch of marl may represent an overlap, but I am more inclined to think that the clay represents a mass which was pushed southward by glacial action, overriding the marl and thus making the normal position of the two series appear reversed.

If the existence of the cretaceous marl belt is definitely known in eastern Massachusetts[2] we should then have to form somewhat the following ideas for the former limits of the cretaceous strata eastward.

The clay belt extended in a narrow strip around the southern limits of the archæan ridge of Staten Island, and northeastward to the East River. Thence it broadened out to an unknown extent, became narrow again towards the eastern end of Long Island and finally disappeared somewhere along the southern New England coast. The marl belt evidently extended to the south shore of Staten Island, crossed Long Island diagonally, curved northward into what is now the basin of the Sound, and thence continued to a limited extent around the New England coast, north of Martha's Vineyard.

Negative evidence that these were probably the limits of the eastward extension of the cretaceous formation is also to be noted. No cretaceous material, either in place or in the moraine, has yet been found on the island of Nantucket. If cretaceous strata of any extent formerly existed to the north or northwest of that island some indications of them ought to be found in the moraine, as is the case on the islands westward.

[The paper was illustrated by maps.]

THE RELATIONS OF PRIMARY AND SECONDARY STRUCTURES IN ROCKS. By Prof. C. R. VAN HISE, University of Wisconsin, Madison, Wis.

[ABSTRACT.]

THE purpose of the paper is to inquire into the relations of cleavage and fissility to bedding. It was shown that in homogeneous rocks the laws of hydrostatic viscous flow or the laws of shearing apply, and therefore that the secondary structure cuts the primary structure. This may be called cross cleavage or cross fissility. In heterogeneous rocks in which the beds are of varying strength the accommodations between the beds

[1] Ries, H., Bull. N. Y. State Mus., iii (1895), 128.

[2] Hitchcock, E., Am. Journ. Sci., vii (1824), 240-248, and xxii (1832), 1-70; Shaler, N. S., Bull. Geol. Soc. Am. (1890), 443-452.

control the major movements. The secondary structure is produced by shearing, and is therefore parallel to the bedding, and this may be called parallel cleavage or parallel fissility. However, in heterogeneous rocks at the crests and troughs the laws applicable to homogeneous rocks chiefly apply, while the law of accommodation applies upon the limbs. In passing from the limbs of the folds to the arches and troughs, the two tendencies are at work, and the phenomena are the resultant of both.

[This paper will be printed in 16th Annual of U. S. Geological Survey.]

GEOLOGICAL NOTES ON THE ISLES OF SHOALS. By HORACE C. HOVEY, D.D., 60 High Street, Newburyport, Mass.

[ABSTRACT.]

THE Isles of Shoals (originally Smith's Isles) were discovered by Capt. John Smith in 1614. They are nine miles from Portsmouth light, and are nine in number; five belonging to Maine, and four to New Hampshire In 1800 the group was surveyed, showing Appledore Island to have 350 acres, Star Island 150 acres, Haley's Island 100, and the others less area. A light-house is on White Island. Haley and Malaga are joined by a sea wall that makes the safe harbor. The scenery, history and botany of the group have had attention, but according to Hitchcock, Crosby and others. the geology has been neglected, being regarded as identical with that of the neighboring coast. Hence the present writer has thought it worth while to investigate. with the result offered in these notes, which may be regarded as preliminary to more thorough work at some future time. Every one of the islands was examined and soundings taken in their vicinity. Facts seem to show Star, Haley, Cedar and Malaga islands to be steadily rising at the rate of six feet in fifty years; while the rest are either stationary or sinking. The proofs of this were given.

The general rock is granitic, varying from white to black, and with remarkable dykes and other signs of igneous action. These dykes being of material softer than their surroundings yield to the action of the sea, making deep channels, which are occasionally at right angles with each other. Many proofs are given of the great force of the wintry storms in the transportation of boulders, etc. Large boulders are swept completely across the islands, and even tossed to the top of cliffs fifty feet high. Extraordinary pot-holes are cut by the rotation of boulders by the waves.

The author particularly wishes to describe a singular column on Appledore Island, quarter of a mile north of the hotel, in a ravine open to the sea. The column protrudes through biotite gneiss, softer than itself, and the gneiss lies between walls of white granitic rock harder than itself. The diameter of the column is eleven feet, and what is visible of it would measure eleven feet eight inches, if undisturbed. Probably the original height was from twenty-five to fifty feet. It is sharply hexagonal. Being

but a short distance above high water mark it has been repeatedly assailed by the sea, giving way at lines of cleavage twenty inches apart. Two sections are in place; one lies upon these, although moved by the waves five feet back; a double slice is in contact with these; while another double slice lies 100 feet northeast of the column. The material of the column has not been determined though it is probably granite crushed and baked by contact with the dyke. The occurrence is remarkable and worthy of further investigation.

A striking dyke of porphyry is also described, found on Cedar Island, and stretching from shore to shore. Large garnets are found, on Appledore Island, from one to four inches in diameter. Other peculiarities are mentioned as a contribution to the knowledge of this small but interesting "neglected group."

The paper was illustrated by specimens and photographs.

[This paper will be printed in The Scientific American.]

SUBDIVISIONS OF THE UPPER SILURIAN IN NORTHEASTERN IOWA. By Prof. ANDREW G. WILSON, Lenox College, Hopkinton, Iowa.

[ABSTRACT.]

THIS paper, after a brief review of the literature of the subject, attempts to give characteristics, lithological and palæontological, that will be sufficient to determine the following subdivisions of the Niagara in northeastern Iowa.

5. The building stone.
4. The upper coralline beds.
3. The Pentamerus beds.
2. The lower coralline beds.
1. The beds of passage from the Maquoketa Shales.

[This paper will be printed in American Geologist.]

SUPPLEMENTARY NOTES ON THE METAMORPHIC SERIES OF THE SHASTA REGION OF CALIFORNIA. By JAMES PERRIN SMITH, Stanford University, California.

[ABSTRACT.]

IN the limestones of the Trias of Shasta county there is a remnant of an old system of folds, which for several miles show the zigzag outcrops and ridges, like those of Pennsylvania and Arkansas. These have already been briefly described by the author,[1] but were here described in greater detail.

The Carboniferous argillites, probably of Artinsk or Lower Permian age were described, and mention made of the characteristic species.

[1] Journ. Geol., Vol. II, No. 6, 1894, p. 589.

New finds in the Middle Trias shales were noted, making the age assigned to them more probable.

The ranges of faunas in the Karnic horizon of the Upper Trias were discussed; it was noted that while in the Alps and the Himalayas the *Trachyceras* fauna always occurs below the *Tropites subbullatus* fauna, in California the two faunas occur in the same beds. We have, then, in California either a survival of the *Trachyceras* fauna longer than elsewhere, or else the *Tropites subbullatus* fauna appeared there before it reached other regions, where Upper Trias is now known. The latter explanation seems preferable, for the *Tropitidæ* are endemic in the Pacific region, while the *Trachyceræta* are immigrants in it.

The finding of an upper Karnic. or more probably Juvavic, fauna was also mentioned. In this the *Trachycerata* had all disappeared, but the *Tropitidæ* still continued, although modified.

Should the fauna turn out to be really of Juvavic age, it is the youngest Triassic fauna yet known in America, and the only occurrence of this yet found outside of the Alps.

THE GREAT FALLS OF THE MOHAWK AT COHOES, N. Y. By W. H. C. PYNCHON, Trinity College, Hartford, Conn.

[ABSTRACT.]

THE location of the Falls and a brief description of them.

The general laws which govern the formation of water-falls.

Peculiarities of the Cohoes Falls when considered with reference to these laws:

1. Peculiar strike and dip of the rocks of the vicinity.
2. Structure of the banks of the river at the falls.

Neither of these gives an explanation of a fall at this point.

Review of the conditions existing at Niagara.

Evidences of similar conditions at Cohoes.

Inferences to be drawn:

1. That the lower Mohawk Valley is a young valley, and.
2. That the falls are formed by the wearing back of a preëxisting escarpment.

The indications that this is the case.

Questions which follow from these conclusions:

1. Was there a valley of the lower Mohawk older than the present one?
2. If so, where was this valley, and why was the river diverted from it?

Evidences of the existence of this older valley.

Its location and general description.

Apparent reasons for the diversion of the river.

Some minor details. Need for further investigation.

[The paper was illustrated by lantern slides. It will be printed in American Journal of Science.]

GEOLOGICAL CANALS BETWEEN THE ATLANTIC AND PACIFIC OCEANS. By Dr J. W. SPENCER

[ABSTRACT.]

OVER the Isthmus of Tehuantepec, in Mexico, low plains now eroded made a shallow strait of a few miles in width connecting the basin of the Mexican Gulf with the Pacific Ocean. The land is now raised about 1000 feet above sea level. Through these straits there are two lower canals about 800 feet above sea level, only a mile long, and quarter of a mile wide, whose floors are covered with gravels which are continuous with terraces upon the Gulf side. There are various terrace plains on both sides of the divide, the features of which will be elaborated at some future time. The importance of these straits and canals is many fold. They are along the site of the old drainage of the Mexican valley. The shallow waters admitted surface mollusks and fish from the Pacific Ocean to the Gulf of Mexico but excluded the deep sea forms, which last are entirely of Atlantic character (Brown Goode). The canals formed the last stages of connection between the two oceans.

The date of the elevation belongs to a recent terrace epoch at least later than the Columbia period. From the physical standpoint, it seems that this is an important feature, for the structure is identical in character with the gravel floors of *cols* south of the Great Lakes which have been regarded as evidence of glacial dams. This discovery unexpectedly supported my position taken many years ago, that such gravel floors are not evidence *per se* of glacial dams.

RECENT ELEVATION OF NEW ENGLAND. By Dr. J. W. SPENCER.

[ABSTRACT.]

THE high terraces in the valleys of New England are not those of rivers but of estuaries. They are often from 50 to 250 feet above the valleys and can be followed at approximately the same level for sometimes twenty miles, while the streams descend. Accordingly the terraces consist of a succession of almost level steps, over the fronts of which the streams descend through ravines or among hills with steep slopes. Such occur along the valleys on the north and east, south and west of the New England highlands from at least an elevation of 2700 feet downward, and in every direction the terraces have the same characteristics. From these features, it is inferred that these steps represent changes in the base plane of erosion, or in other words successive uplifts in the most recent post glacial times, in amount approximately equal to the aggregate heights of the terraces. Thus these terraces become yardsticks for the measurement of recent uplifts of large areas. From correlations with terraces and beaches further west probably nearly 2000 feet of this great elevation has occurred since the birth of Niagara Falls. This great elevation in the center of the mountain mass does not necessarily require that the

coastal regions should have been raised up from equal depth, for the movements appear to be greater in the mountain regions than nearer the sea.

VIEW OF THE ICE AGE AS TWO EPOCHS, THE GLACIAL AND CHAMPLAIN. By WARREN UPHAM, Cleveland, Ohio.

[ABSTRACT.]

THE present paper supplements that presented by the author in the Proceedings of this Association a year ago, which showed the Quaternary era as divisible in the Lafayette, Glacial, and Recent periods. The Glacial period or Ice age is here more particularly reviewed, and is found divisible in two parts or epochs, the first or Glacial epoch being marked by high elevation of the drift-bearing areas and their envelopment by vast ice-sheets, and the second or Champlain epoch being distinguished by the subsidence of these areas and the departure of the ice, with abundant deposition of both glacial and modified drift. Epeirogenic movements, first of great uplift, and later of depression, are thus regarded as the basis of the two time divisions of the Ice age. Each of these epochs is further divided in stages, marked in the Glacial epoch by fluctuations of the predominant ice accumulation, and in the Champlain epoch by successively diminishing limits of the waning ice-sheet.

Studies by many observers have shown that both in North America and Europe the border of the drift along the greater part of its extent was laid down as a gradually attenuated sheet; that the ice retreated and the drift underwent much subaërial erosion and denudation; that renewed accumulation and growth of the ice-sheets, but mostly without extending to their earlier limits, were followed by a general depression of these burdened lands, after which the ice again retreated, apparently at a much faster rate than before, with great supplies of loess from the waters of its melting; that moderate re-elevation ensued, and that during the farther retreat of the ice-sheets prominent moraines were amassed in many irregular but roughly parallel belts, where the front at successive times paused or re-advanced under secular variations in the prevailingly temperate and even warm climate by which, between the times of formation of the moraines, the ice was rapidly melted away.

Such likeness in the sequence of glacial conditions doubtless implies contemporaneous stages in the glaciation of the two continents; and the present writer believes that it is rather to be interpreted as a series of phases in the work of a single ice-sheet on each area than as records of several separated and independent epochs of glaciation, differing widely from one another in their methods of depositing drift.

Under the latter view, however, James Geikie distinguishes no less than eleven stages or epochs, glacial and interglacial, which he has very recently named (Journal of Geology, vol. III, pp. 241-269, April-May, 1895), since the publication last year of the new edition of his "Great

Ice Age," in which, however, they were fully described. These divisions of the Glacial period are as follows: 1. The Scanian or first glacial epoch; 2. The Norfolkian or first interglacial epoch; 3. The Saxonian or second glacial epoch; 4. The Helvetian or second interglacial epoch; 5. The Polandian or third glacial epoch; 6. The Neudeckian or third interglacial epoch; 7. The Mecklenburgian or fourth glacial epoch; 8. The Lower Forestian or fourth interglacial epoch; 9. The Lower Turbarian or fifth glacial epoch; 10. The Upper Forestian or fifth interglacial epoch; and 11. the Upper Turbarian or sixth glacial epoch.

The earliest application of such geographic names to the successive stages and formations of the Ice age appears to be that of Chamberlin in his two chapters contributed to the new third edition of Geikie's admirable work before mentioned, in which he names the Kansan, East Iowan, and East Wisconsin formations. For the second and third he has since adopted the shorter names, Iowan and Wisconsin. This classification he has more recently extended (Journal of Geology, vol. III, pp. 270-277, April-May, 1895), the interglacial stage and deposits between the Kansan and Iowan till formations being named Aftonian, and the Toronto interglacial formation, previously named, being referred, with some doubt, to an interval between the Iowan and Wisconsin stages. Chamberlin correlates, with a good degree of confidence, his Kansan stage of maximum North American glaciation with the maximum in Europe, which is Geikie's Saxonian epoch; the Aftonian stage as Geikie's Helvetian; the Iowan as the European Polandian; and the Wisconsin or moraine-forming stage of the United States as the Mecklenburgian, which was the stage of the "great Baltic glacier" and its similarly well developed moraines. According to the law of priority, the names of the Kansan, Iowan, and Wisconsin formations and stages should also be applied to these European divisions of the Glacial series, for the studies of Geikie and Chamberlin show them to be in all probability correlative and contemporaneous.

Differing much from the opinions of Geikie, and less widely from those of Chamberlin, concerning the importance, magnitude, and duration of the interglacial stages, but agreeing with Dana, Hitchcock, Wright, Kendall, Falsan, Holst, Nikitin, and others, in regarding the Ice age as continuous, with fluctuations but not complete departure of the ice-sheets, my view of the history of the Glacial period, comprising the Glacial epoch of ice accumulation, and the Champlain epoch of ice departure, may be concisely presented in the following somewhat tabular form. The order is that of the advancing sequence in time, opposite to the downward stratigraphic order of the glacial, fluvial, lacustrine, and marine deposits.

EPOCHS AND STAGES OF THE ICE AGE.

I. The Glacial Epoch.

1. THE CULMINATION OF THE LAFAYETTE EPEIROGENIC UPLIFT, affecting both North America and Europe, raised the glaciated areas to so high altitudes that they received snow throughout the year and became deeply

ice-enveloped. Valleys and fjords show that this elevation was 1,000 to 4,000 feet above the present height.

Rudely chipped stone implements and human bones in the plateau gravels of southern England, 90 feet and higher above the Thames, and the similar traces of man in high terraces of the Somme valley, attest his existence there before the maximum stages of the uplift and of the Ice age. America appears also to have been already peopled at the same early time.

The accumulation of the ice-sheets, due to snowfall upon their entire areas, was attended by fluctuations of their gradually extending boundaries, giving the Scanian and Norfolkian stages in Europe, and an early glacial recession and re-advance in the region of the Moose and Albany rivers, southwest of Hudson bay.

2. KANSAN STAGE. Farthest extent of the ice-sheets in the Missouri and Mississippi river basins, and in northern New Jersey. The Saxonian stage of maximum glaciation in Europe.

Area of the North American ice-sheet, with its development on the Arctic archipelago about 4,000,000 square miles; of the Greenland ice-sheet, then somewhat more extended than now, 700,000 square miles or more, probably connected over Grinnell land and Ellesmere land with the continental ice-sheet [the area of Greenland is approximately 680,000 square miles, and of its present ice-sheet, 575,000 square miles]; of the European ice-sheet, with its tracts now occupied by the White, Baltic, North, and Irish seas, about 2,000,000 square miles.

Thickness of the ice in northern New England and in central British Columbia, about one mile; on the Laurentide highlands, probably two miles; in Greenland, as now, probably one mile or more, with its surface 8,000 to 10,000 feet above the sea; in portions of Scotland and Sweden, and over the basin of the Baltic sea, a half mile to one mile.

3. HELVETIAN OR AFTONIAN STAGE. Recession of the ice-sheet from its Kansan boundary northward about 500 miles to Barnesville, Minn., in the Red river valley; 250 miles or more in Illinois, according to Leverett; but probably little between the Scioto river, in Ohio, and the Atlantic coast, the maximum retreat of that portion being 25 miles or more in New Jersey. A cool temperate climate and coniferous forests up to the receding ice border in the upper Mississippi region. Much erosion of the early drift.

The greater part of the drift area in Russia permanently relinquished by the much diminished ice-sheet, which also retreated considerably on all its sides.

During this stage the two continents probably retained mainly a large part of their preglacial altitude. The glacial recession may have been caused by the astronomic cycle which brought our winters of the northern hemisphere in perihelion between 25,000 and 15,000 years ago.

4. IOWAN STAGE. Renewed ice accumulation, covering the Aftonian forest beds, and extending again into Iowa, to a distance of 350 miles or more from its most northern indentation by the Aftonian retreat, and

re-advancing about 150 miles in Illinois, while its boundary eastward from Ohio probably remained with little change.

The Polandian stage of renewed growth of the European ice-sheet, probably advancing its boundaries in some portions hundreds of miles from the Helvetian retreat.

II. The Champlain Epoch.

5. CHAMPLAIN SUBSIDENCE; NEUDECKIAN STAGE. Depression of the ice-burdened areas mostly somewhat below their present heights, as shown by fossiliferous marine beds overlying the glacial drift up to 300 feet above the sea in Maine, 560 feet at Montreal, 300 to 400 feet from south to north in the basin of Lake Champlain, 300 to 500 feet southwest of Hudson and James bays, and similar or less altitudes on the coasts of British Columbia, the British Isles, Germany, Scandinavia, and Spitzbergen.

Glacial recession from the Iowan boundaries was rapid under the temperate (and in summers warm or hot) climate belonging to the more southern parts of the drift-bearing areas when reduced from their great preglacial elevation to their present height or lower. The finer portion of the englacial drift, swept down from the ice-fields by the abundant waters of their melting and of rains, was spread on the lower lands and along valleys in front of the departing ice as the loess of the Missouri, the Mississippi, and the Rhine. Marine beds reaching to a maximum height of about 375 feet at Neudeck, in western Prussia, give the name of this stage.

6. WISCONSIN STAGE. Moderate re-elevation of the land, in the northern United States and Canada advancing as a permanent wave from south to north and northeast; continued retreat of the ice along most of its extent, but its maximum advance in southern New England, with fluctuations and the formation of prominent moraines; great glacial lakes on the northern borders of the United States.

The Mecklenburgian stage in Europe. Conspicuous moraine accumulations in Sweden, Denmark, Germany, and Finland, on the southern and eastern margins of the great Baltic glacier. No extensive glacial re-advance between the Iowan and Wisconsin stages, either in North America or Europe.

7. WARREN STAGE. Maximum extent of the glacial lake Warren, held on its northeast side by the retreating ice border; one expanse of water as mapped by Spencer, Lawson, Taylor, Gilbert, and others, from lake Superior over lakes Michigan, Huron, and Erie, to the southwestern part of lake Ontario; its latest southern beach traced east by Gilbert to Crittenden, N. Y., correlated by Leverett with the Lockport moraine.

This and later American stages, all of minor importance and duration in comparison with the preceding, cannot probably be shown to be equivalent with Geikie's European divisions belonging in the same time.

8. TORONTO STAGE. Slight glacial oscillations, with temperate climate nearly as now, at Toronto and Scarboro', Ont., indicated by interbedded

deposits of till and fossiliferous stratified gravel, sand, and clay. Although the waning ice-sheet still occupied a vast area on the northeast, and twice re-advanced, with deposition of much till, during the formation of the Scarboro' fossiliferous drift series, the climate then, determined by the Champlain low altitude of the land, by the proximity of the large glacial lake Algonquin, succeeding the larger lake Warren, and by the eastward and northeastward surface atmospheric currents and courses of all storms, was not less mild than now. The trees whose wood is found in the interglacial Toronto beds now have their most northern limits in the same region.

9. IROQUOIS STAGE. Full expansion of the glacial lake Iroquois in the basin of the present lake Ontario and northward, then outflowing at Rome, N. Y., to the Mohawk and Hudson rivers. Gradual re-elevation of the Rome outlet from the Champlain subsidence had lifted the surface of lake Iroquois in its western part from near the present lake level at Toronto to a height there of about 200 feet, finally holding this height during many years, with the formation of the well developed Iroquois beach.

Between the times of lakes Warren and Iroquois, the glacial lake Lundy, named by Spencer from the beach ridge of Lundy's Lane, probably had an outlet east to the Hudson by overflow across the slope of the highlands south of the Mohawk; but its relationship to the glacial lake Newberry, named by Fairchild as outflowing to the Susquehanna by the pass south of Seneca lake, needs to be more definitely ascertained.

10. ST. LAWRENCE STAGE. The final stage in the departure of the ice-sheet which we are able to determine from the history of the Laurentian lakes and St. Lawrence valley was when the glacial lake St. Lawrence, outflowing through the Champlain basin to the Hudson, stretched from a strait originally 150 feet deep over the Thousand Islands, at the mouth of lake Ontario, amd from the vicinity of Pembroke on the Ottawa river, easterly to Quebec or beyond. As soon as the ice barrier was melted through, the sea entered these depressed St. Lawrence, Champlain and Ottawa valleys; and subsequent epeirogenic uplifting has raised them to their present slight altitude above the sea level.

Later stages of the glacial recession are doubtless recognizable by moraines and other evidences, the North American ice-sheet becoming at last, as it probably also had been in its beginnings, divided into three parts, one upon Labrador, another northwest of Hudson bay, as shown by Tyrrell's observations, and a third upon the northern part of British Columbia. From my studies of the glacial lake Agassiz, whose duration was probably only about 1,000 years, the whole Champlain epoch of land depression, the departure of the ice-sheet because of the warm climate so restored, and most of the re-elevation of the unburdened lands, appear to have required only a few (perhaps four or five) thousand years, ending about five thousand years ago. These late divisions of the Glacial period were far shorter than its Kansan, Aftonian and Iowan stages; and the ratio of the Glacial and Champlain epochs may have been approxi-

mately as ten to one. The term Champlain conveniently designates the short final part of the Ice age, when the land depression caused rapid though wavering retreat of the ice border, with more vigorous glacial currents on account of the marginal melting and increased steepness of the ice-front, favoring the accumulation of many retreatal moraines of very knolly and bouldery drift.

Only with a rate of ablation much faster and with glacial currents much stronger than those of the Arctic regions or of the continental ice-sheets during their time of accumulation under the severe climate of their high plateau elevation, in short, only during the Champlain epoch, when the land had sunk from its preglacial and glacial altitude both in America and Europe, could noteworthy peripheral moraines be amassed. They record on each continent the definite closing epoch of the Glacial period.

[This paper is more fully published in the American Geologist, Vol. XVI, pp. 100-113, August, 1895, with two maps showing the Kansan, Iowan, and Wisconsin boundaries of the North American and European ice-sheets.]

TERMINOLOGY PROPOSED FOR DESCRIPTION OF THE SHELL IN PELECYPODA.

By Prof. ALPHEUS HYATT, Cambridge, Mass.

[ABSTRACT.]

THE term *hinge line of the shell* in Pelecypoda is usually applied to the joint between the valves of the shell and includes, as a rule, the entire articulation, which is directly used to hold the valves in place when they are being opened or closed. This is the most important part usually considered in the descriptions of bivalve shells and perhaps the most constant in its fundamental characters.

The paper suggests that this area be termed the articulus or hinge in allusion to its functional character.

The shell consists of the inner nacreous calcareous layer, the middle or shell layer proper of calcareous matter and the periostracum (so called epidermis) which is horny and is an external layer.

The hinge of the youngest stage of the shell is straight and the connection between the valves is made by the ligament or continuous unbroken layer of periostracum of which the ligament is a thickened differentiation.

The middle layer and the nacreous layer are discontinuous along this primitive hinge line but the periostracum is unbroken from the first embryonic stage of the shell.

This primitive hinge, which is usually called the cardinal line, can be properly termed the *cardo* and is persistent in a number of shells even in adults, for example, in Arcidæ.

In the majority of existing bivalves, however, this cardinal line and area becomes, during the growth of the individual, confined to a certain

part of the articulus; either to a limited central part, amphidetic type of Neumayr, or posterior to the beaks, opisthodetic type of the same author. In all of these modifications it maintains the same characters. The outcropping edges of the bands of growth of the middle layer or true ostracum in passing around the shell cease abruptly at the edges of this area. however limited it may be. In the extreme old age of the shell or in phylogerontic types, *i. e.*, those in which entire growth is similar or parallel with that of this stage in the development of the normal individual, this is not the case, and in these (Ostreidæ, Hippuritidæ, etc.) the shell is largely built up by layers plastered upon the inner surface which do not thin out and the external bands of growth cannot be said to be discontinuous at the cardo.

In many shells (Arcidæ) this same mode of growth is seen and the external bands of growth are continuous across and parallel with the cardinal line. This mode is the same but it is perfectly regular and there is a sharp line or angle between the external bands of growth and those on the hinge. The cardinal area separating the beaks of many shells is built in this way. This is therefore a phylogerontic characteristic.

The cardo is coextensive with the ligament and continuous periostracum and is also coincident with the internal closed parts of the mantle.

The cardo varies from the external diamond shape it has in Arcidæ to a crescentic form in the Mactridæ. This last shape is due to the excessive growth of the anterior shell and posterior shell layers dorsally. These encroach upon the cardinal area, narrowing its longitudinal diameter and converting the amphidetic area from a diamond into truncated shape, *Mya arenaria*, or a crescentic outline, *Mactra solidissima*.

A further modification of this same mode of growth usually (not invariably) combined with spiral valves and occurring at an early stage separates the crescentic area into two branches or forks which pass from the end of the linear ligament of the cardinal area anteriorly and outwardly under the beaks, as in Isocardidæ. The whole course of the forks or branches is the true cardo and is marked by the remains of the ligament, using that term as Dall uses it for the external parts only, the resilium being the internal cushions developed in Mactridæ and many other shells as defined by that eminent malacologist.

The articulus or hinge includes not only the cardo but also a greater or less proportion of the dorsal parts of normal shells. It naturally includes the internal hinge plate in the center and posteriorly and anteriorly to the beaks and the corresponding external line. all of which are functional in effecting the perfect closure by securing exact apposition in the valves.

The cardo is coextensive with the articulus not only in the Arcidæ but also in a very large proportion of the Aviculidæ and Pectenidæ. The resilium and the ligament in these shells are continuous and supplement each other in securing the apposition of the valves.

The cardo and the articulus necessarily have, as shown by Jackson, the same general relations to the direction of the organic or mesal axis of the body as determined by situation of the oral and anal apertures and the relations of other parts notably the gills. Both of these are dorsal as pointed

out by that author in all of the elongated normal Pelecypoda and they are anterior or at right angles to this in the winged forms or Ostreidæ, Aviculidæ, Pectenidæ and their allies.

In comparing two shells of these morphic extremes we must therefore hold them so that the mouths are in the same position and the articuli at right angles to each other.

The terminology here suggested for the other parts divides the exterior of the shell according to its internal structure. The anterior and posterior regions are in most shells divided by a central region which is internally occupied by the branchiæ, more than by any other part, and this is also usually distinguishable externally by the fact that the external bands of growth are broader and the spiral axis of greatest growth of the valve is therefore in this region. I suggest for this the terms umbonal or branchial region. The areas are as follows:

The oral area reaches in normal shells, Unionidæ, Mya, Pholas, etc., from the anterior extremity of the cardinal line to the anterior side of the pedal area.

This last or pedal area often has a well-marked swelling or elevation and sometimes a distinct sinus on the margin, Pholadidæ. The pedal area is frequently succeeded as one passes towards the posterior pole by a depression marked by a sinus on the margins of the valves. This commonly corresponds to the posterior termination of the body and the beginning of the center of the branchial chamber and can be called the branchial sinus. This is often succeeded by a swelling or elevation but sometimes continues as a depression to the beginning of the next area, but in either case in a general way it corresponds with the umbonal axes of the bands of growth and may be properly termed the branchial area.

The next area is the siphonal area distinguishable externally in all normal elongated shells in the posterior region by the presence of one and often two obtuse angles in the lines of growth, the ventral and dorsal angles of this area. The ventral angle is often more prominent than the umbonal elevation (Mactridæ) and may be called the siphonal crest.[1]

The dorsal siphonal angle is rarely prominent and often indistinguishable, although as a rule the bands of growth here change direction for a second time in passing on to the next or intestinal area.

The intestinal area is included between this angle and the posterior end and side of the cardinal or ligamental area when the former is entirely covered in by the latter, as it often is in opisthodetic types.

The application of this nomenclature can be best seen in such highly specialized types as Pholadidæ, in which, in consequence of the different uses of the ends of the body, the areas are not only defined in the outlines of the margins but in some genera distinguished by different styles of ornamentation. In other shells, especially orbicular forms, it will be found useful, if considered as artificial and used in a modified sense. That is to say, in such shells the attempt at a systematic description beginning

[1] The term ridge should, I think, be reserved for large and extraordinary parallel bands of growth and costæ for radiating ridges or true costations.

with the articulus and cardo and following the areas around from the oral to the anal pole antero-posteriorly will bring out the fact that in such or such species in which the oral area and pedal areas are not distinguishable there is a branchial sinus; or, on the other hand that, as often happens, these areas all run together and the siphonal area is enormously developed or disproportionately truncated, as in Donax.

In applying the terminology to the Aviculidæ there is no greater difficulty to overcome than that which has just been stated except with regard to the wings.

The natural description of the cardo is an anterior articulus, which is, as a rule, a true, usually amphidetic, cardo with a cardinal area. The shelly extensions of the cardinal line on either side of the beaks are in these shells, especially Pectenidæ, truly ventral and truly dorsal, if the shells be held in the proper positions as described above. They cannot be called anterior and posterior as is common with conchologists without violation to the relations of the internal parts. This will be more clearly seen in the application of this terminology.

Starting from the cardinal area anterior to the beaks, there is first the oral area, but this is the ventral wing and in these forms should be thus designated. The pedal area is commonly a deep sinus or notch and has a good name already, the byssal sinus or notch. Then the study of the next area, or branchial area, brings out clearly that this area is not distinguishable from the inhalent part of the siphonal area. and also that this area includes all the central and posterior parts of the shell following in its growth, the gills, which last pass entirely around the great muscle or posterior muscle more or less in a crescent and terminate on the dorsum. This termination is more or less marked, often in Aviculidæ, by a prominent crest, like the siphonal crest of many normal Pelecypoda. But this is differently situated being in consequence of the dorsal position of the ends of the gills brought around to the dorsal side of the animal, and in many cases through part of its course becoming part of the concave edge of the dorsum and intestinal area. In other words, it often is a single angle in the bands of growth and is curved concavely instead of convexly as in normal Pelecypoda and approximate more or less in many forms to the margin of the intestinal area.

The application of this or any nomenclature of the parts meets with obstacles of course in some forms and these show also its utility. Thus in Malleus the phylogerontic growth of the shell carries out the articulus in an entirely distinct way from that of any other Pelecypod. The young of this shell, as pointed out by Jackson, is a form with a hinge and the wings and outline like Perna.

At the termination of the earlier stages of growth, after the shell is about half an inch in its antero-posterior diameter the ventral wings cease growing. No additions are made to them and they are not directly continuous as commonly supposed with the so-called anterior wings of this shell. On the contrary the bands of growth forming these extensions are situated on the opposite side of the pedal area or byssal notch and morphically belong to the same area.

A RESURVEY OF THE WHIRLPOOL AND VICINITY OF THE NIAGARA RIVER, WITH A DEMONSTRATION OF THE TRUE GEOLOGY OF THE LOCALITY. By GEO. W. HOLLEY, Ithaca, N. Y.

[ABSTRACT.]

THE paper gives an account of a new survey of the whirlpool and its vicinity, with description of some preglacial crevasses and other points concerning the origin of the Niagara gorge, illustrated by a large map giving some entirely new and original features of the geology of the vicinity.

GLACIAL PHENOMENA BETWEEN LAKE CHAMPLAIN AND LAKE GEORGE AND THE HUDSON. By Prof. G. FREDERICK WRIGHT, Oberlin, O.

[ABSTRACT.]

THE paper gave the results of recent personal exploration of the region.

THE ARCHEAN AND CAMBRIAN ROCKS OF THE GREEN MOUNTAIN RANGE IN SOUTHERN MASSACHUSETTS. By Prof. B. K. EMERSON, Amherst, Mass.

[ABSTRACT.]

DESCRIPTION of a series of Archean anticlines partly overturned and overthrust westward, and of the unconformity of the Cambrian conglomerate gneiss upon the older rocks.

THE GEOLOGY OF WORCESTER COUNTY, MASS. By Prof. B. K. EMERSON, Amherst, Mass.

[ABSTRACT.]

A preliminary account of the progress of work in mapping the crystalline rocks of Central Massachusetts.

INTERESTING FEATURES IN THE SURFACE GEOLOGY OF THE GENESEE REGION, NEW YORK. By Prof. H. L. FAIRCHILD, University of Rochester.

[ABSTRACT.]

THIS paper is intended only as an informal exhibition of lantern views, with running description, of some phenomena in the glacial and lacustrine deposits of western New York.

DISTRIBUTION OF SHARKS IN THE CRETACEOUS. By Dr. C. R. EASTMAN, Cambridge, Mass.

[ABSTRACT.]

COMPARISON of geographical distribution of certain of the more important genera of Elasmobranchs in the Cretaceous of Europe, Asia, and

North America; with inferences as to their relationships, and, where the genera are represented by recent forms, inferences as to climatic conditions; differences in geographical distribution of fossil and recent sharks. and a discussion of the value of evidence afforded by free-swimming forms in general. Also a notice of the occurrence of genera known in the European Cretaceous, but hitherto unknown in the American, recently discovered in the Niobrara group of western Kansas.

JAPAN. By GARDINER G. HUBBARD, LL.D., President of the National Geographic Society, Washington, D. C.

[ABSTRACT.]

THE paper begins with the physical description of the numerous islands forming the Empire of Japan—its numerous inland waters, bays, gulfs, and harbors, affording unusual facilities for commerce — its mountain ranges, studded with volcanoes, running through the islands.

The influence of earthquakes on the architecture and habitations of the people.

The former and present races of Japan, with a concise account of the government of Japan prior to 1850.

Of the opening of Japan to the world by Commodore Perry of the United States Navy.—followed by the downfall of the government of the Shogun and the reëstablishment of the rule of the Mikado.

The development of the government since 1860, down to the establishment of the present constitutional form of government.

The surrender of the lands by the Damaios to the Mikado and the creation of a debt caused by such settlement, with some account of the finances of the government.

The character of the Japanese mind, little understood by us, and its effect upon their habits of thought and lives.

Effect of this development on the character of the inhabitants of the cities and the peasantry. Great difference between Eastern and Asiatic civilization, and inquiry as to how far our civilization should be adopted by the Japanese; or whether it is wise for them to modify their own by ours.

The rapid growth of the mining and manufacturing interests of Japan and its probable effect upon the manufactures of England and their trade with China, India, and Asia generally.

Japan can easily supply the Pacific Coast with manufactures, while the Pacific Coast and the Gulf States, through the Nicaragua Canal can supply fruits, provisions, grain and cotton to Japan, thus supplying a large outward and homeward commerce for our vessels plying the Pacific ocean.

THE EQUATORIAL COUNTER CURRENTS. By Prof. W. M. DAVIS, Cambridge, Mass.

SECTION F.

ZOÖLOGY.

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PAPERS READ.

THE AFFINITIES OF THE PYTHONOMORPH REPTILES. By Prof. E. D. COPE, 2102 Pine St., Philadelphia, Pa.

[ABSTRACT.]

THE differences in cranial structure which obtain between the Ophidia and Lacertilia were given. The homologies of the elements which support the quadrate bone were discussed. A comparison between these parts in the Pythonomorpha and other Squamata was made, and the ophidian characteristics of the former pointed out, in opposition to the views of various zoölogists who have written on the subject since 1871.

[This paper will be printed in the American Naturalist.]

ON THE VISCERAL ANATOMY OF THE LACERTILIA. By Prof. E. D. COPE, Philadelphia, Pa.

[ABSTRACT.]

THE relative positions of the head and lungs and other viscera, especially those of the Amphisbænia and Thecaglossa were mentioned.

The characters of the urino-genital system of the Teidæ were described. The hepatic and gastric mesenteries were described, and new characters of several groups were pointed out.

[This paper will be printed in Proc. Amer. Philosoph. Society.]

ON THE OLFACTORY LOBES. By Dr. CHARLES SEDGWICK MINOT, Harvard Med. School, Boston, Mass.

[ABSTRACT.]

THE author traces the limits of division between the portions of the olfactory lobes arising from the ganglia and from the cerebrum. Describes the layers of the lobe and embryonic condition of the cerebral layers in the adult. This paper was illustrated by blackboard sketches.

REJUVENATION AND HEREDITY. By Dr. CHARLES SEDGWICK MINOT, Harvard Medical School, Boston, Mass.

A NEW WHEEL FOR COLOR MIXING IN TESTS FOR COLOR VISION. By Prof. J. H. PILLSBURY, Stoneham, Mass.

[ABSTRACT.]

THE apparatus described is a wheel so constructed that a gradually increasing amount of color may be introduced while the disks are in rotation. The apparatus was exhibited and explained.

SOME FURTHER RESULTS OF INVESTIGATIONS OF AREAS OF COLOR VISION IN THE HUMAN RETINA. By Prof. J. H. PILLSBURY, Stoneham, Mass.

[ABSTRACT.]

A series of charts showing the results of investigations of areas of color vision of human retina.

THE EUPAGURIDÆ. By CHARLES W. HARGITT, Ph.D., Syracuse, N. Y.

[ABSTRACT.]

A review of the morphological characteristics of the family, its habits, distribution, and significance of the facts in relation to the inheritance of acquired characters.

THE EVOLUTION OF THE INSECT MOUTH PARTS. By JOHN B. SMITH, Sc.D., New Brunswick, N. J.

[ABSTRACT.]

IN this paper the ordinary mandibulate mouth is taken as the starting point and the modifications of all the sclerites are separately traced until the most highly specialized suctorial mouth is fully homologized with the normal mandibulate type.

The illustrations are all microphotographs from actual specimens showing all the steps in the development. This paper was illustrated by a series of lantern views.

THE MOUTH-PARTS OF INSECTS WITH PARTICULAR REFERENCE TO THE DIPTERA AND HEMIPTERA. By C. L. MARLATT, Dep't of Agriculture, Washington, D. C.

[ABSTRACT.]

AN explanation of the general type of insect mouth is given and the incorrectness of the common terms, mandibulate and haustellate, used to separate insects into two groups, pointed out, it being shown that insects of all orders are, strictly speaking, mandibulate. The correctness of the

classification of insects in two main groups based on mode of nourishment, viz., a group of biting insects and a group of sucking insects, is shown, and the legitimacy of the terms suggested by Westwood for these two groups—dacnostomata (biting mouth) and antliostomata (sucking mouth)—is illustrated. The characteristics of the sucking mouthparts of insects are described, with particular reference to the orders Diptera and Hemiptera. The practical accuracy is shown of the view generally held that the principal mouth organs—mandibles, maxillæ, labrum, labium, etc.—are well developed in these two orders; and the total lack of basis for the recent effort to show that the mouthparts of these orders are wholly maxillary, the other mouth organs being either rudimentary or absent, is pointed out and illustrated by reference to typical species. The paper is illustrated by several charts showing mouth organs of typical insects of different orders.

STEMMIULUS AS AN ORDINAL TYPE. By Prof. O. F. COOK, Huntington, N. Y.

[ABSTRACT.]

THE genus *Stemmiulus* was described by Gervais in 1844, but has never been subjected to careful dissection. From abundant material collected in Liberia the author has made a more extended examination and announces the following unique characters:—

1, Ocelli one or two, very large. 2, Lingual laminæ equal in size with the stipes of the gnathochilarium. 3, Legs eight-jointed. 4, Second legs of male modified for copulatory purposes. 5, Behind the second pair of legs is inserted a long, two-jointed seminal duct. 6, Pleuræ distinct. 7, Segments with dorsal setæ, after the manner of Chordeumidæ, and with repugnatorial pores as in Iulidæ. 8, Pores subdorsal. 9, Segments divided by fine longitudinal lines into narrow areas. 10, Segments not constricted in the middle into subsegments. 11, Last segment with six conic setiferous processes.

These characters justify the recognition of Stemmiulus as an ordinal type.

[This paper will appear in the American Naturalist.]

ON A REVISION OF THE NORTH AMERICAN CRASPEDOSOMATIDÆ. By Prof. O. F. COOK, Huntington, N. Y.

[ABSTRACT.]

IN collaboration with Mr. G. N. Collins, a revision of the N. A. Craspedosomatidæ has been completed in which ten genera are recognized, of which four are new. The genera Trichopetalum, Cryptotrichus, Zygonopus and Scoterpes are maintained as distinct from each other and from

the European genus Craspedosoma to which European authors have reduced them. The genus Campodes Koch (1847) applied by Bollman to Cryptotrichus is found to have been based on a species of Iulus, *I. flavicornis* C. L. Koch.

[This paper was illustrated by plates. It will be printed in Annals of the N. Y. Academy of Sciences.]

A NEW CHARACTER IN COLOBOGNATHA, WITH DRAWINGS OF SIPHONOTUS. By Prof. O. F. COOK, Huntington, N. Y.

[ABSTRACT.]

UNTIL the present year the genus Siphonotus of Brandt has not been rediscovered, the only specimen extant being the type in the Berlin Museum. Abundant material collected at Sierra Leone enables a demonstration of the fact that in this order there are eight pregenital legs, of which the first five segments bear one each, the sixth two, the seventh one.

[This paper will be printed in the American Naturalist.]

CHARACTERS USEFUL IN DESCRIBING LARVÆ OF SPHINGIDÆ. By GEORGE DIMMOCK, Ph.D., Canobie Lake, N. H.

[ABSTRACT.]

THE author reviews certain characters especially useful in recognition of the various larval stages of Sphingidæ, considering those which have been most neglected by describers. Care in measuring and describing the head is emphasized; since, from its changes at each successive moult, most species of lepidopterous larvæ can be recognized. The importance of better descriptions of the granulations and rugosities of larvæ was shown, and the significance of the structure and coloration of the stigmata, as well as the differences of the prothoracic stigmata from the succeeding pairs pointed out. Mention was also made of the circumstance that the first larval stage of some species of Hemaris have dichotomously forked hairs, a fact of considerable value in establishing the relationship between Sphingidæ and other heterocerous lepidoptera, and one not hitherto published. The paper was illustrated by colored blackboard sketches.

ON THE GIRDLING OF ELM TWIGS BY THE LARVÆ OF ORGYIA LEUCOSTIGMA, AND ITS RESULTS. By Prof. J. A. LINTNER, New York State Entomologist, Albany, N. Y.

[ABSTRACT.]

THE author has noted that the twigs of elms in Albany are annually girdled to a greater or less extent by these larvæ which eat away the

bark in a narrow ring a few inches below the extreme tip. This decortication renders the twigs very brittle, and they fall off, as broken at these points by the wind. The girdling appears to be solely for the purpose of feeding on the tender bark. Arrest of the sap at the girdled points results in a bulbous-like enlargement of the twigs. Examples of the girdled twigs were exhibited.

A STUDY OF PANORPA AND BITTACUS. By E. PORTER FELT, D.Sc., Northboro, Mass.

[ABSTRACT.]

PANORPA and Bittacus are our common representatives of the small order Mecoptera. They are popularly known as Scorpion-flies. The adult Panorpa is a carrion insect, feeding upon the body-fluids of their prey. They also feed greedily upon raw meat. The closely allied genus, Bittacus, will feed only upon living prey. Like Panorpa, they do not devour, but suck the body-fluids. The adults of both genera are common in moist woods.

Panorpa lays her eggs in masses of about twenty-seven in the crevices of the sand. The eggs are oval, yellowish, and hatch in six to seven days. The larvæ have a general resemblance to lepidopterous larvæ. They have eight pairs of rudimentary prolegs on the first eight segments. On the tenth segment there is a retractile, four-branched, anal-fork. On the dorsum of each abdominal segment there is a pair of segmented, pilose spines, except the tenth, where there is a single median spine. The spines on the eighth to the tenth segments are the largest, the others become reduced to rudiments at the end of the first moult.

The larvæ burrow in the ground. They usually feed when lying in the mouths of their burrows, which open under their food. In nature they may prey upon small animals. They grow rapidly and reach the seventh stage within twenty days after emerging from the egg. This paper was illustrated by charts.

TEMPERATURE FLUCTUATIONS OF CATTLE AS BEARING ON THE "TUBERCULIN TEST." By JULIUS NELSON, Ph.D., N. J. Agricultural College Experiment Station, New Brunswick, N. J.

[ABSTRACT.]

THE author has found in his experience that whenever the injection of tuberculin caused a sure rise of the temperature of a cow, above the normal, it infallibly indicated the presence of tuberculosis, though it was necessary in rare and incipient cases to call in the aid of the microscope to determine the presence of the specific bacilli. On the other hand, not all

tuberculous cows respond by such a fever reaction; in the author's experience all gradations in the extent of the disease, from slight to extreme development of tuberculosis, were presented by cases of non-reaction that were slaughtered and carefully autopsied. Investigations along this line should be greatly extended before a proper verdict on the value of the Koch test can be rendered. Another source of failure of this test in indicating *all* cases of tuberculosis is our inability to predict, within narrow limits, what the highest temperature of an animal will be under normal conditions on any day, after ascertaining the maximum for the day previous. At first a margin of nearly three degrees was allowed for the average cow; this has now been reduced to one and a half degrees in the practice of leading veterinarians, but it is plain that a reaction smaller than this must take place in some instances.

The author has been recording and studying an extended series of observations of the temperature of the cows in the dairy herd of the State Agricultural College at New Brunswick, N. J. The results so far obtained may be summarized thus:

(*a*) Some animals that fail to show a reaction at one date of injection may do so at a later date when the injection is repeated.

(*b*) Animals that have reacted give generally a lower reaction curve when the injection is repeated, and after three or four injections entirely cease to respond.

(*c*) The reaction curve is nearly symmetrical, but in some cases the temperature returns to the normal much more slowly than it rose.

(*d*) Reaction curves occurred, at irregular intervals, due to unknown causes, in several animals that were not under influence of tuberculin.

(*e*) Cows are nearly all alike in having a primary maximum temperature at 6 P. M., and a secondary maximum at 8 A. M.

(*f*) Each cow has its own individuality and a distinct mean whose height has no relation to age, but in very young calves this mean is higher than in older animals.

(*g*) The temperature curve fluctuates with great irregularity up and down, best shown in half hour intervals.

(*h*) In many cases these changes in the curves coincide throughout the herd, the causes of which have not been clearly ascertained.

(*i*) The temperature rises after eating and falls after drinking; is lower when the animal stands than when lying down; rises with deeper insertion of thermometer; and in some cows, prolonged insertion raises the temperature.

(*j*) Thermometers should be tested from time to time and compared with standard instrument. The certificate of maker is not always reliable.

(*k*) The temperature fluctuations of the air influence *directly* the height of the mean temperature of a herd.

[This paper was illustrated by a series of charts. It will be printed, with important additions, in the Annual Report of New Jersey Agricultural College Experiment Station for 1895.]

RESOLUTIONS PASSED BY SECTION F.

At a special meeting of the Section September 2, 1895, the following resolutions were adopted :—

WHEREAS: The date of publication is a question of fact to be determined by investigation and not by arbitrary ruling, and

WHEREAS: In the world at large the date of publication of books is the date at which they are printed, and

WHEREAS: The adoption of any other date by us would have no practical effect for this reason, and for the following additional reasons, viz.:—

First, the majority of publications are not distributed but sold;

Second, the distribution, when it occurs, may be rendered ineffective by accident, such as fires, loss of mail, etc.;

Third, distribution by individuals may be delayed or prevented by absences from home, sickness or death;

Fourth, distribution by governments is often delayed for routine reasons;

Fifth, the actual date of mailing will often be impossible to ascertain with certainty owing to lack of record, or irregularity in the period of transmission, and

WHEREAS: The determination of the date of printing will be generally found in the records of the printing office and can be established by the testimony of several disinterested persons, while the date of mailing will be known generally by but one person, therefore

BE IT RESOLVED: First, that the Zoölogical Section of the A. A. A. S. recommends that the date of the completion of printing of a single issue be regarded as the date of publication; and

Second, that the Section recommends that such date be printed on the last signature of all publications, whether books, periodicals, or "separates."

RESOLVED: (1) That the Section of Zoölogy of the A. A. A. S. is impressed with the desirability of introducing the custom of placing all publications on record at some central agency, together with the date of publication.

(2) That a committee be appointed to obtain the approval of these resolutions by publishing societies at home and abroad.

(3) That a copy of these resolutions be transmitted to the British Association for the Advancement of Science, Zoölogical Society of London, Australasian Association for the Advancement of Science, Association Française, Société Zoologique de France, Versammlung der Naturforscher und Aerzte, Zoologische Gesellschaft, and the International Congress of Zoölogy.

The President of the Section appointed the following as the Committee mentioned above:

S. A. FORBES, Champaign, Ill., E. A. BIRGE, Madison, Wis., W. A. LOCY, Lake Forest, Ill., GEORGE DIMMOCK, Canobie Lake, N. H.

CHAS. W. HARGITT, Sec'y Section F.

SECTION G.

BOTANY.

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Vice President.

J. C. ARTHUR, Lafayette, Ind.

Secretary.

B. T. GALLOWAY, Washington, D. C., until Saturday, afterwards M. B. WAITE, Washington, D. C.

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B. L. ROBINSON.

Sectional Committee.

L. M. UNDERWOOD, *Vice President*, 1894, C. R. BARNES, *Secretary*, 1894, J. C. ARTHUR, *Vice President*, 1895, B. T. GALLOWAY, *Secretary*, 1895, M. B. WAITE, *Secretary*, 1895, N. L. BRITTON, WM. TRELEASE.

Member of Nominating Committee.

DAVID F. DAY.

Committee to Nominate Officers of the Section.

Vice President and Secretary and F. V. COVILLE, F. H. KNOWLTON, WILLIAM TRELEASE.

Press Secretary.

W. T. SWINGLE.

ADDRESS

BY

J. C. ARTHUR,

VICE PRESIDENT, SECTION G.

DEVELOPMENT OF VEGETABLE PHYSIOLOGY.

THERE is a certain fitness in bringing before the section of this Association, which has been most recently established, some account of that department of botanical science, which is one of the latest to be brought into notice as a grand division of the subject. For vegetable physiology, the topic which is to engage our attention, is like a western or African domain, long inhabited at the more accessible points, more or less explored over the larger portion, but with undefined boundaries in some directions, and with rich and important regions for some time known to the explorer, but only now coming to the attention of the general public. In fact, our domain of vegetable physiology is found to be a diversified one, in some parts by the application of chemical and physical methods yielding rich gold and gems, in other parts coming nearer to every man's daily interests with its fruits and grains. Thus it comes about that, before the public is well acquainted with the name of the science, it has differentiated itself into two or three sciences, having quite separate objects in view.

It is the purpose of this address to acquaint you with the growth and present outlines of the group of sciences, which for convenience are included under the heading of vegetable physiology, and also to show why they deserve recognition as important constituents of a liberal education along with other natural sciences. The point of view at all times will be that of the American botanist.

In the development of botany in America the science has passed through successive waves or stages of popularity, constantly in-

creasing in momentum, widening its scope by evolution of new interests, and more and more exhibiting virility by its adaptability to the needs of the times. That botany has in it something that may be transmuted into money has only recently been discovered, but it is a discovery that is likely to work benefit not only to the practical man who makes application of scientific truths to commercial ends, but also reciprocally to the investigator who thinks only of uncovering a new fact or establishing a new law. To adequately meet the requirements of modern botany in the way of laboratories, gardens, herbaria, libraries, and apparatus requires a capital that not long since would have been deemed fabulous. The money to meet this demand of a growing science must be expected to come in the main as the voluntary contribution of an interested public, — the reciprocal response to the attitude of botany toward the general welfare.

I have mentioned the economic aspect of botany thus early, because it is one of the significant changes which has come over the science within the last decade or two, and to which vegetable physiology in some of its features is, I venture to say, about to add further important contributions. Science no longer shrinks into the shadow of the closet for fear of being implored to lend a hand at securing revenue, but steps forth and curiously scrutinizes every process of the practical world, often finding there its most fruitful fields for fundamental research.

The problems of vegetable physiology possess to a greater or less degree a special element of interest not inherent in those of other departments of botanical science. They embrace the dynamical property of motion, which never fails to exercise a fascination over the human mind. Physiology, in fact, deals with what plants do, their methods of activity, their behavior; while the other divisions of botany treat of what plants are, or have been, their form, structure, and relation of parts. The one is the study of the organic machine in action, and the other the contemplation of its component members.

Movement in plants does not attain the rapidity exhibited by animals. Some movements in both cases are ultra-visual, as the translocation of molecules in metabolism, the diffusion of gases, and in plants especially the flow of liquids. In plants even the movements of the organs are comparatively slow. While the leaves of the sensitive plant, telegraph plant, and Venus's fly-trap,

and the petals of certain orchids excite the wonder of the casual beholder, most plant organs move too slowly to be readily detected without mechanical magnification. This does not prove a detraction to the interest of the subject, however, as it has led to the invention of ingenious and complicated machines, whose numerous wheels and bands inspire a sense of importance, particularly appealing to a large class of persons in this age of machinery, and constituting an element in securing favorable attention from the public, while it adds a charm to the work of the investigator, rivalling that of the microscope. It is yet but the dawning of day for the display of mechanical contrivances as aids to botanical research, and the future gives promise of notable achievements. The names of Barnes, Anderson, Stevens, Stone, Golden, Thomas, Frost, and Arthur at present are representative of the American inventive spirit in botany. The most perfect and interesting pieces of apparatus yet turned out by them embrace Frost's and Golden's auxanometers for recording the increase in length or thickness of growing organs, Thomas's apparatus for recording the variation in pressure of sap resulting from root action, Anderson's automatic balance for registering the rate and amount of change in the weight of an object, used in studying transpiration and growth, and Arthur's clinostat for neutralizing the action of gravity and light, and his centrifugal apparatus for substituting mechanical force for that of gravity.

While having in mind the public interest in our science, it may be well to notice the very small basis of information on which this interest is founded. Only the vaguest notions are current regarding the nutrition of plants, the uses of the leaves, the movements of sap, the purposes of color, and the means by which new positions are assumed. This ignorance is primarily due, of course, to the same cause which has so long delayed the development of the science upon the technical side: the fact that almost nothing can be learned of the functions of plants from direct observation. In regard to the physiology of animals, even the lowest, much may be inferred by observing their behavior, and analyzing the phenomena from the human standpoint, but there are no obvious similarities between plants and the higher animals, and it is necessary to resort to careful experimentation and profound study to arrive at a fair understanding of the vital actions of plants. Physiology is an experimental science, and the public

must perforce derive its knowledge second hand without much opportunity of verification. It must be admitted that, although a view of this portion of the *res publica naturæ* has its fascination, yet the attainment of vantage ground for the survey is necessarily difficult and slow.

The term public, when used in connection with vegetable physiology, needs to be construed liberally. It will include, without doubt, some able scientists and men of liberal education. I may be permitted to cite an occurrence to which some in this audience were witnesses. Some time since the subject of gases in plants was before the Association, and induced an animated discussion. Probably half of those participating confounded respiration, which is a general function of all plants, as well as animals, under all conditions of existence, with the photosyntactic function of fixation of carbon by the green parts of plants in the presence of sunlight. Both processes have to do with oxygen and carbon dioxide, but the resemblance goes no further. It is an error dating back tó the last century, when the two processes were discovered, and one for which botanists themselves are by no means without responsibility. Another error not yet dislodged from the cobwebby corners of many a well-read man's intellectual storehouse is the old fiction of a circulation of sap, so dear to those who desire to find analogies in plants with the physiological processes of animals. It is not much over fifty years since the learned French Academy exhibited its ignorance of vegetable physiology by awarding the grand prize to an essay founded upon this error; and the error still lives.

But the general ignorance of even the best established and most readily apprehended facts of physiology may be justly extenuated when the pedagogical status of the subject is examined. Botany, as a substantial part of the curriculum, cannot be said to have received recognized standing in the American educational system until the time of Asa Gray. In the latter part of the decade of the thirties his first text-book, the "Elements of Botany," appeared, and in the decade following, the "Text-book for Colleges" and the "Manual," all of which works showed a true appreciation of the best features of the science and the needs of the time. They were so well conceived, and so much in demand, that new editions rapidly succeeded one another; and to the present day they hold a high place in the estimation of botanical teachers. These works pos-

sessed a specially potent element of virility in being the expression of knowledge at first hand, the words of the master. In so far as inspiration was drawn from foreign sources it came chiefly from French and English scholars, of whom De Candolle the eldest and Robert Brown were the representatives.

A half century ago vegetable physiology, in the fulness of the modern meaning of the words, did not exist. Structural botany was then the dominant phase, and in elementary instruction took the shape of close attention to the form and arrangement of the organs of flowering plants, with the ulterior object of being able readily to determine the names of the plants of the field. Even then physiology presented some attractive features, but they appeared largely extra-territorial, as the title of the book from which most of us received our early botanical pabulum testifies: "First Lessons in Botany *and* Vegetable Physiology," by Asa Gray, issued in 1857, and continuing its supremacy as a text-book until 1887, when it was revised and renamed.

In the seventies botanical laboratories began to form a necessary feature of the best institutions, each with its quota of compound microscopes and reagents, in which we followed the example of Germany, such laboratories having been established at Halle, Breslau, Munich, and Jena a decade previous, and subsequently at many other centres of learning. With the advent of Sachs's "Text-book of Botany" in English dress about this time, the science in America took on a new and vigorous phase of development. The method of this work found more convenient expression in Bessey's "Botany" (1880), which for a decade was the recognized standard of instruction. A wealth of laboratory guides soon appeared, and American botanists became devotees of microscopic anatomy. I scarcely need call your attention to the triumphal advancement of botany during the decade of the eighties, it is so fresh in every one's mind. It amounted to a revolution; the work of the herbarium was wellnigh abandoned for the study of the cell. Those of the older systematic botanists who took no part in this upheaval became alarmed, and put forth vigorous protests, claiming with much justice that pupils so trained lost breadth of view and proper perspective. An editorial writer in the *Botanical Gazette* very clearly contrasted the two methods of instruction. "The ancient method," said he, "gives a wide range of acquaintance with external forms, a general knowledge of the plant kingdom and its

affinities, a living interest in the surrounding flora; but it disregards the underlying morphology of minute structures and chemical processes, the great principles which bring plant life into one organic whole. The modern method, on the contrary," he continues, "takes a few types, carefully examines their minutest structures and life work, and grounds well in general biological principles; but it loses the relation of things, as well as any knowledge of the display of the plant kingdom in its endless diversity, and, worse than all for the naturalist, cultivates no love for a flora at hand and inviting attention. The former is the method of the field, the latter of the laboratory."

But under both ancient and modern methods of instruction, whether the teacher were a systematist or histologist, whether the pupil pulled apart flowers under a hand lens, or dissected tissues under a compound microscope, botany flourished in America. There was, in reality, a better philosophy abroad than usually appeared in practice. The layman, remembering his school days, might assert with Julian Hawthorne that "botany is a sequel of murder and a chronicle of the dead," but the professional botanist, imbued with the spirit of the times, resented the imputation as no fault of the science; and while deploring the well enough known mediævalism and incompetence of teachers, who only disclosed a descriptive and classificatory science, with marvellous wealth of terminology to be sure, but as lifeless and unbiological as mathematics or astronomy, pointed to the motto held by all the progressionists, "the study of plants as living things."

The revivifying spirit which was pervading the botanical world, which strove to find in plants more than objects for the glossologist and the cataloguer, which interrogated the plant upon matters of action as if a dumb intelligence, which diffused a new light and a higher significance into every fact of the science, had its source in that all-pervading influence which emanated from the observations and interpretations of Charles Darwin. The brilliant series of works upon the behavior and relationship of plants by this author, beginning with the pollination of orchids in 1862 and extending through a score of years, left a profound impress upon botanical thought, based as they were upon the connecting thread of evolution. So different now was the point of view that there sprang up what was called the "new botany." Although the inspiration of the "new botany" was general, yet it manifested

itself pedagogically chiefly in elementary instruction and in special studies. We may pass the delightful brochure of Asa Gray on "How Plants Behave" (1872) with a bare mention, as it appeared too early to show any peculiarities of method not familiar to the readers of Darwin, and call to mind the much less pretentious presentation of the new way as understood by Beal under the title of "The New Botany" (1881). He declares it to be a study of "objects before books," in which "the pupil is directed and set to thinking, investigating, and experimenting for himself." The new method did not fit equally well into all departments of botany, and found its best expression for the most part in developmental and physiological subjects. It was in fact the chief agent in preparing the ground for the crop of physiology that is now being sown, and sown in a field selected and staked out by Darwin and Sachs.

Having shown how the field for the reception of the latest botanical husbandry was prepared, I may now briefly trace the source of the ideas with which it was implanted, and in doing so it is necessary to point out that vegetable physiology, as the term is generally employed, is not a homogeneous science.

The advancement of any subject is promoted by a clear understanding of its outlines, and it is in the interest of clear concepts and convenient usage, that certain natural limitations should be respected by physiologists. Not that intergradation and mutual dependence do not occur, but that certain natural boundaries may be more or less distinctly recognized which will throw the subject matter into sections and simplify the presentation of the numerous facts of the science.

The most obvious distinction to be made in the physiological aspect of organisms is in regard to their maturity. The organism in its embryonic or juvenile condition manifests functional peculiarities of the highest import, quite unlike those of the adult. The physiology of reproduction belongs here, and includes not only a study of the formation and increase of the young plant, that is, embryology, but genesiology as well, that is, the philosophy of the transmission of qualities and powers from the parent to the offspring, both in vegetative and sexual reproduction. It is a curious fact, which Vines has recently called attention to, that even vegetative reproduction, as in the case of the growth of a plant from a cutting, brings about rejuvenescence of the protoplasm, the new individual showing the characters of youth, and

not of maturity. In both sexual and asexual reproduction the attention should be focussed chiefly upon the behavior of the cell, and a wonderful complexity will be found in these minute structures. The mystery of a world is bound up in this bit of protoplasm, and corresponding to the *multum in parvo* aggregation of properties there seems to be an unsolved intricacy of structure. To the study of what was originally supposed to be essentially homogeneous protoplasm, we have gradually distributed and extended the properties of the cell to the cytoplasm, the plastids, the nucleus, the nucleoli, the fibrillar network, the chromosomes, the centrosomes, the kinoplasmic spindle, and the polar bodies. What further distribution of function will eventually be found it is too early in the history of investigation to prognosticate.

But it is not every dividing cell that points the way to a new individual. Plants with complex structures possess tissues of embryonic character, such as the cambium, whose utmost power of division only leads to the production of additional tissues like those adjoining it, but are wholly incapable of originating a new individual, or even a new organ. From this histogenic extreme all gradations and variations occur, to the perfectly reproductive spore, which by its growth forms another individual without contributing anything to the support of the parent organism.

Beside the elementary riddles of life bound up in the processes of cellular reproduction, or cytiogenesis, there are others relating to nutrition, growth, and irritability, which comprise what animal physiologists group under the term "cellular physiology," for which Professor Verworn of Jena made such an impassioned plea in the *Monist* about a year ago. We find, said he, "that even the minutest cell exhibits all the elementary phenomena of life, that it breathes and takes nourishment, that it grows and propagates itself, that it moves and reacts against stimuli," and therefore he urged that far more attention should be given to this department of physiology, as the key to many complicated processes. The physiological study of the cell, including both its reproductive and vegetative aspects, in so far as they may be considered the nascent functions of the elementary parts of the organism, may be conveniently considered under a single heading, "caliology."

Passing to the physiology of the adult organism, a little reflection will show that the activities of the plant may be considered from two standpoints: that of the plant's individual economy,

and that of the plant's social economy, or its relation to other plants and animals, and the world at large. Looking at the latter phase more closely, we shall find that the subject contains some of the most interesting topics in the range of botany, which appeal especially to the lover of nature, without losing their value as problems of the deepest scientific import. Among the relations of plants to the world at large may be mentioned the influence of climate, the means of protection against rain, drouth, and cold, adaptation to the medium in which the plant grows, and the establishment of rhythmical periods. Among the relations of plants to animals are those interesting chapters in the pollination of flowers by insects, the contrivances by which plants with a predilection for highly nitrogenous food may capture and feed upon insects, and the means adopted by plants to prevent injury from large animals, which are more or less familiar to the general public through the writings of Charles Darwin. Among the relations of plants to one another comes foremost the struggle for existence, bringing into play the laws of natural selection and the survival of the fittest, together with much else that is now known under the head of evolution, followed by various phases of parasitism, mutualism, and other topics. Is it not evident from this hasty and by no means complete outline that here is a portion of physiology which appeals to all classes of thoughtful persons, rich in possibilities for the philosophical and speculative mind, and bristling with queries demanding experimental solution?

Although this department of physiology has received much attention here and there for a long time, and some of its topics are well understood, yet only very recently has it fallen into place as a systematic part of the general subject, and no separate presentation of it has yet appeared in English, and only two works in German. There is some confusion regarding the name of the science. The Germans call it "biology," which may serve to emphasize the importance of regarding the plant as a living, plastic being, but is not an exclusory term, and also does violence to its philological derivation. Even the recently proposed modification into phytobiology does not much improve the term. The English usage of the word biology, as so admirably set forth by Huxley, and more or less consistently adopted in this country, leaves no place to introduce the imperfect usage of the Germans. Two years ago, in his wholly delightful "Chapters in Modern

Botany," Patrick Geddes proposed the term "bionomics." The same year, however, a better term was advocated almost simultaneously in England and America. The Madison Botanical Congress indorsed the word "ecology" as the designation of this part of physiology; and only a few days later Professor Burdon-Sanderson, in his Presidential Address before the biological section of the British Association, outlined the science and traced the origin of the name ecology, of which he made use.

Ecology, therefore, is the name under which we are to attempt the orderly arrangement of the facts, observations, and deductions composing the science, in which, to quote Burdon-Sanderson, "those qualities of mind which especially distinguish the naturalist find their highest exercise." The first independent treatise on the subject is by Wiesner (Vienna, 1889), and is an excellent model, while Ludwig's work, issued a few months since (Stuttgart, 1895), which is the second and to the present time only similar work, cannot be so highly praised. A work in English is greatly to be desired.

Having disposed of the external or sociological economy of the adult plant under the heading of ecology, we turn to the consideration of the internal or individual economy. This is the portion of physiology now in the ascendency, and the part which is usually more particularly intended under the present usage of the term vegetable physiology. The tendency is to restrict the titular use of the term to this part of the subject alone, which is to be approved. This gives us three well defined departments in the science of the activities of plants; caliology, ecology, and physiology.

Physiology, in the restricted sense, deals with the most vital of problems, how the individual lives. It pertains to the way in which plants breathe, secure and use their food, adjust themselves to light, heat, moisture, and the contact of other bodies. It deals with what botanists in the days of Linnæus, and even down to within the last fifty years, would have called the products of the *vis vitalis*. It desires to know what the specific energies of the plant are capable of accomplishing, in short, what is going on within the plant in the way of life processes. As will be readily seen, the whole matter is summed up in an exhibition of energy, which in former days was called vital energy, and thought to reside exclusively in living organisms, but now held to be only

a special manifestation of the general physical forces of the universe.

The energies of plants fall into two categories, those which bring about changes in the intimate structure of vegetable substances, and those which bring about movement; and hence we call physiology a superstructure whose foundation is chemistry and physics. The present great advance in the science may, in large measure, be traced to the wonderful advances in the sciences of chemistry and physics, which have supplied facts and methods to assist the physiologist in his study of life processes.

Yet it would be an egregious mistake to suppose that physiology is but a dependency of chemistry and physics. The substitution of the so-called mechanical philosophy of life for the old vitalistic philosophy has not in any way rendered the vital activities less wonderful, or the protoplasmic display of energy less complex, less inscrutable, or less *sui generis*. The meaning of the word life shows no likelihood of being solved until the chemical and physical constitution of the protoplasmic molecule is understood, and that is too far away to make speculation at this time worth while; and so we need not quarrel with those who fancy that even when that advanced goal is reached the problem will not be solved, but a mysterious residuum will still exist to endow protoplasm with autonomy. Be that as it may, the path of present advancement keeps steadily onward in the clear light of physical laws, and ignores the nearness of mystical, unfathomable shadows.

But returning from this long digression in separating physiology into the three reasonably distinct sciences, — caliology, ecology, and physiology proper, — we will proceed with the inquiry regarding the present scientific status and its course of attainment in each of the three branches. It is not, however, any part of my purpose to give a philosophical or historical disquisition upon the subject, but merely to point out a few landmarks to enable us to get our bearings, so that we may spy out the land and obtain some opinion of what there may be good or bad in it.

The subject of caliology, that is, the various phases of juvenescence, including especially the dynamics of the young cell, has not yet received systematic presentation. Although a vast array of facts have been recorded, mostly to be sure as the concomitants of morphological studies and scattered so widely as to be almost lost, yet the value of the subject as a separate inquiry has not yet

much impressed itself upon botanical students. There are, doubtless, most excellent reasons for this, not in any wise dependent upon the importance or attractiveness of the subject. The action of a machine as a whole depends upon the interaction of its parts; and to fully understand its operation requires a knowledge of its mechanism. No adequate theory of the physiological processes in the mature organism was possible until the character of the cellular framework and the distribution of tissues had been well worked out; and in the investigation of cellular physiology there occurs the same inherent difficulty. The structure of the cell in all its microscopic detail must be ascertained, and when the microscope fails us, there must be well-framed theories of the physical organization of the parts, before solid advancement in understanding cellular activity can be expected.

The labors of Strasburger have been especially noteworthy in establishing an adequate morphological basis for the interpretation of cellular activity. If we were to point to a single work as particularly conspicuous in this connection, it would be his *Zellbildung und Zelltheilung* (1875), which introduced hardening and staining methods into the study of the cell, and may be said to have created a new school of histologists, even more conspicuously represented among zoölogists, possibly, than among botanists. Great accuracy and a far clearer interpretation have been attained by the new methods, causing a rapid accumulation of trustworthy facts regarding the parts of the cell, especially of the reproductive cell and its neighbors, and of the succession of changes as the young organism or as the histogenic elements pass toward maturity. In this important work America can count some able investigators and valuable contributions, especially in making known the development of the metaspermic embryo and accompanying changes.

Morphological knowledge of the cell and of the stages in reproduction must necessarily be followed by inquiry into physiological processes. Already the writings of De Vries, Strasburger, Klebs, Vöchting, Wiesner, and Vines have indicated the directions for study. The greatest impulse to the physiological study of reproduction, however, has been given by Weismann, although not himself a botanist, and not drawing heavily from the botanical storehouse to support his theories. Nägeli's idioplastic theory of 1884, and De Vries's later theories, have not of themselves been sufficient to arouse botanical enthusiasm. The whole domain of

caliology is suffering, in fact, for leaders, — men chiefly known for their researches in this field. The science needs a Linnæus, a Sachs, or a Gray to bring it into prominence and to inspire enthusiasm and a following. Some day it will be in vogue.

Upon turning to ecology, we find the conditions wholly changed. There are elements of popularity in the science that have made some of its topics familiar to the general reader, even before the boundaries of the science have been mapped. The fascinating and epoch-making observations of Charles Darwin on the pollination of orchids and other flowers, at the same time bringing to light the long lost Pompeian-like treasures of Sprengel, gave an impulse to a line of study still full of promise. The extensive writings of Müller, Delpino, and in our own country Charles Robertson, have provided large stores of knowledge, and at the same time opened up attractive vistas for further observation.

Thus we might enumerate many other topics, which are more or less familiar to every one having the slightest acquaintance with botany, and to some others as well. If we ask how these matters came to be so widely known, the answer is not far to seek, and not obscure. The marvellous inspiration which came with the writings of Charles Darwin, and the fact that he cultivated ecological subjects more than any other, together with his theories of adaptation and natural selection which provided a key to the riddles of nature, making what were before matters of course now matters of the liveliest import, turned the attention of the botanical world, and of all other lovers of plants as well, even of some who cannot be placed in either class, in this direction. We may call Darwin the father of vegetable ecology, for had he not written, the field would have lain largely uncultivated and uninteresting.

In America the year 1887 saw the establishment of a series of state institutions, which gave a wonderful influence to the study of ecology. American botany owes much to the Agricultural Experiment Stations, especially in promoting a knowledge of vegetable pathology and ecology. Together with the Agricultural Department of the general government, they have enabled American botanists to become the leading investigators and writers upon pathological subjects, giving a position and imparting a value to the science of plant diseases, both scientific and practical, that ten years ago would have been inconceivable. What has been done for pathology is likely to be done for ecology, as it is the second

subject in importance cultivated by station botanists. In the latter science the assistance of the Agricultural Colleges is also important, for in a few years the subject will undoubtedly hold a commanding position in the curriculum of the agricultural and general science courses of these institutions, and be regarded as the culminating and leading feature of a course of botanical study. It may seem presumptuous and fanciful to claim so much and be so positive in face of the fact that at the present time the subject is a *nomen incognitum* to the makers of curricula in these institutions; but careful examination of the subject matter of the science shows that even in its present rather chaotic condition it embraces more points of vital interest to the lover and cultivator of plants than other departments of botany, being less recondite, and yet at the same time underlaid with a broad and attractive philosophy. What is most needed at present is a suitable text-book; for the value of the subject will be more quickly recognized when it is displayed in well arranged form.

It would be interesting and profitable to take a survey of the development of the different branches and topics of the science, but I shall content myself with barely mentioning one or two which especially flourish in this country. Recently a new life has been infused into the study of floras and the distribution of plants by what is called the "biological" method, the inspiration having been derived in the first place from the zoölogists. This method, which has so far been most successfully applied to limited areas in the western part of the United States, undertakes an explanation of the present location of forms by considering severally and collectively the various external and inherent factors promoting and restricting their development, including the reciprocal influence of proximity. Of the names prominent in this connection, those of Coville, Trelease, and Macmillan are especially worthy of mention. The last has done good service by calling attention to the significance of tension lines, in his account of the "Metaspermæ of the Minnesota Valley." There is a phase of phylogenetic study which has received some attention of late, in form of the breeding of plants. It is a subject especially adapted to experiment station work. The leader in this line of research, L. H. Bailey, has also materially promoted ecological studies by his numerous biogenetic and other writings.

Coming to physiology, *sensu stricto*, we find the domain of the

science so well defined and its several areas so well cultivated that a clear statement of its main problems is now possible. Not much advancement was made before the beginning of the present century. The most notable achievements had been the publication of Hales's brilliant work on the pressure and movement of sap, which introduced the physical side of physiology to the world, and Ingenhousz's equally entertaining volume upon his discoveries regarding the uses of green organs, which introduced the chemical side of physiology to the world. The century was ushered in by Knight's classical essays, in which it was first pointed out, among other things, that there was a substantial reason why roots grow downward and stems upward, and by De Saussure's researches upon respiration and other chemico-physiological matters. It is worth mention that Hales, Ingenhousz, Knight, and De Saussure were not botanists, although they cultivated botanical subjects; neither were Senebier, Du Hamel, Dutrochet, Liebig, Boussingault, and others, who assisted in laying the foundations of the science, but were physicists, chemists, and horticulturists. And to this day much important data is contributed to the science by workers in other fields.

Thus facts accumulated, important discoveries were made, and the mysteries of the life processes in plants were gradually unfolded. But it was not until 1865 that the science was given the commanding position due to it. Then appeared the first treatise which set forth the phenomena and laws of vital processes with due regard to proportion, and with clear philosophical insight. Sachs, in his "Experimental Physiology," became the founder of the science in its modern aspect. He set forth with critical discrimination the most important matters pertaining to the organism's relation to light, heat, electricity, and gravity, the processes of metabolism, nutrition, and respiration, and the movement of water and gases in the plant. With rare foresight he excluded all, or nearly all, topics not strictly belonging within the true scope of the science, and presented the whole subject matter in an entirely original form, breaking away from the customs of his predecessors and adopting advanced scientific methods. It was an epoch-making book. As Strasburger has recently said in his history of botany in Germany, "the work at once restored vegetable physiology to its place at the centre of scientific research."

The book has never been translated into English, and so, while

it stimulated the study of physiology in Germany, and physiological laboratories soon became common, led by the famous one at Würzburg, presided over by Sachs, American botany felt little of the new movement until the appearance of Sachs's "Text-book" in English dress a decade later. Even then the new science (for such it was in America) gained but an insecure footing. After another decade, in 1885, appeared the first, and to the present the only, treatise on physiological botany by an American author. This was written by Goodale in response to the desire of Asa Gray to have the several parts of his "Text-book for Colleges" expanded into separate treatises, in order to more fully represent the status of botanical science. As late as 1872 Dr. Gray contemplated writing the work himself, but, his time proving insufficient, he assigned the task to his worthy colleague. The title is used in its broad sense, and included histological anatomy, ecology, and caliology, as well as physiology proper, the last being by no means the most conspicuous part of the book. The encyclopedic fulness of the work better adapted it for a reference-book to accompany a course of lectures than as a text-book. It greatly helped the science in America, however, especially as it stimulated experimental study by a set of laboratory exercises given as an appendix. The year following appeared Vines's "Physiology of Plants," in some respects the most philosophical and well-digested presentation of the science yet written in any language; and only a year later still came Sachs's new treatise on the same subject. These two works were too bulky to serve well as text-books for undergraduate students, but were a source of inspiration to maturer students and to investigators. The present year, completing the third decade since the physiological epoch began, has seen the altogether admirable, although brief, account of the science by Vines, forming part of his "Text-book of Botany," and two excellent laboratory manuals, one by Darwin and Acton of England, and the other an English adaptation by MacDougal of a German work. With these treatises elementary instruction is well provided for, and their effect is already seen in the rapid introduction of the study as a portion of botanical instruction in colleges, and even high schools, throughout the country.

Thus far only the pedagogical side of the science has been brought prominently forward; but what can we say of the research side? So far as America is concerned, there is no research

side; the science is equipped and expanded with facts and theories from foreign sources. A few papers embodying original investigations have been published by American teachers, but they were the result of studies carried on in German laboratories. A dozen or two papers have, indeed, been issued from our own laboratories within the last five years, but all of them have been the work of students, mostly in preparation for a degree. America has nothing to show that can in any wise compare with the important discoveries made and still being made by Francis Darwin in England, De Vries in Holland, Wiesner in Austria, or Sachs, Pfeffer, Vöchting, Frank, and others in Germany. There are ample reasons why this state of things need not be considered humiliating, and yet it is to be deplored as most unfortunate.

Let us turn to a hasty examination of some of the problems of physiology which await solution. They stand out prominently in every chapter of the science, and suggest to the scientific mind most tempting opportunities for original investigation. The nutrition of plants is so imperfectly understood that it may appropriately be said to be a bundle of problems. So little do we know of the processes that even what constitutes the plant's food is in doubt. We know, for instance, that lime and magnesia are taken into the plant, but whether they are directly nutritive by becoming part of living molecules, or whether they serve as aids to nutritive processes, or become the means of disposing of waste materials within the organism, cannot be definitely stated. And to a greater or less extent similar conditions exist respecting potassium, phosphorus, sulphur, iron, and chlorine, which in fact embrace all the so-called mineral elements of plants. The movements and transformations of the two most characteristic elements of organic structures, carbon and nitrogen, are a little better known. Some progress has been made in tracing the steps by which the simple molecule of carbon dioxide derived from the atmosphere is built up into the complex, organic molecule of starch. But the further process by which the starch molecule combines with others to form the most complex and important of all plant substances, protoplasm, is yet an almost complete mystery. The story of the progress of discovery in ascertaining the means by which plants get their nitrogen is a fascinating one, and is not yet ended. These matters in part lie at the very foundation of the most fundamental of industries, agriculture. Intensive

farming, and the highest success in the raising of all kinds of crops, is greatly promoted by a knowledge of the nutritive processes in plants. The botanists, who thirty-five years ago demonstrated that carbon was taken into the plant through the leaves, and not to any material extent through the roots, struck a theme that revolutionized agricultural practice and added greatly to the wealth of the world. The more recent discovery of the connection of symbionts with leguminous and some other plants, by which the abundant supply of nitrogen in the air is converted into food available for higher plants, has also greatly affected agricultural practice. The whole subject of the nutrition of plants is so bound up with intelligent farming and all manner of plant cultivation that advancement of this part of physiology means an increase in material prosperity as well as in scientific knowledge. Ample provision for its prosecution would be a valuable investment for any people, and particularly so for the people of these United States.

There are many ways in which plants show similar physiological processes to those of animals; and plants being simpler in organization, their study may often be made to promote a knowledge of animal physiology. The greatest similarity between the two kingdoms lies in various phases of nutrition, respiration, and reproduction. The greatest divergence is to be found in the manifestation of irritability. Those fundamental processes upon which being and continued existence depend are much the same throughout animate nature, but the processes by which the organism communicates with the world outside of itself, and through which it is enabled to adjust itself to environmental conditions, the processes which in their highest development are known as sensations, have attained great differentiation, running along essentially different lines of development. The prevalent view that plants occupy an intermediate position between the mineral and the animal kingdoms is not true in any important respect. Neither is it true that the faculties of animals, especially of the lower animals, are foreshadowed in plants. No just conception of animate nature can be obtained by conceiving it to lie in a single ascending series. It constitutes two diverging and branching series, like the blades and stems in a tuft of grass, which we may assume have been derived from a common germ. There are two fundamental characters which manifested themselves early in phylogenetic development, one structural and one physiological. The struc-

tural character of the histologic integument of the organism, in animals soft and highly elastic, in plants firm and but slightly elastic, gave rise to the two series of forms, structurally considered, which we call animals and plants. The physiological character of free locomotion for most animals and a fixed position for most plants, determined the line of separation for the development of those powers of the organism classed as irritability and sensation. So great have been the differences which these fundamental characters have brought about, that the stimulating action of external agents, such as light, heat, and gravity, have produced very diverse powers in the two kingdoms. Animals have a wonderful mechanism which enables them to see, while plants have a no less wonderfully specialized sensitiveness by which they assume various positions to secure more or less illumination. Animals have a sense of equipoise, but plants have a very dissimilar and even more remarkable sense of verticality. And so on throughout the list of stimuli, the reactions are not the same, but are differentiated along entirely separate and divergent lines. The period is fortunately well past when physiology was chiefly cultivated with an *arrière pensée* as to its value for interpreting the functions in man, and hence, in claiming for this department of study the most exalted position, and the most intricate and interesting of botanical problems, we need not be distracted by any lurking *cui bono*, or feeling of having come short of ample returns for conscientious effort, although the facts do not elucidate any point in human or animal physiology. Some of the dissatisfaction which caused G. H. Lewes to abandon the pursuit of his early dreams of a comparative psychology, and M. Foster to discontinue his early study of comparative general physiology, as both authors have assured us they did, may possibly be traceable to a lack of singleness of purpose in taking the good of the organism itself in each grade of development as the point of view in pursuing the study. But as all vital activity rests upon a common basis, it is not improbable that the key to some of the fundamental mysteries of physiological action will yet be found in a study of the well developed functions exhibited in the simpler, nerveless structure of plants, and thus a truer philosophy of life in general be attained.

In closing, a few words in regard to the future of vegetable physiology in America may not be out of place. In many ways

the conditions under which botany exists in America are very different from those in other countries. In Europe the class-rooms are filled chiefly with medical students, for whom a moderate amount of botany is considered essential, and the incentive for advanced work in most instances is not strong. In this country the botanical classes are larger, with more varied interests, of which medicine forms only a small part, and the study usually stands upon the same footing as that of the other sciences. The attainment of equal recognition as a substantial element of an educational course, superseding the notion that it constituted only an efflorescence to be classed with belles-lettres and other refinements, was the beginning of a prosperous period. One of the effects of this prosperity was to make the botanist more jealous of his reputation, and with the beginning of the nineties he entered a vigorous protest against the appropriation by the zoölogists of the terms "biology" and "biologist." It was fair evidence that botanists had awakened to a recognition of common interests with the rest of the world, and of the advantages of keeping well abreast with the times. Later, the systematists, finding that other departments of natural history had devised improved ways for naming natural objects, undertook to fall into line and reform the method of naming plants, which led to the first serious break in unanimity which American botanists have known. So warm has been the contention that a few have descended to personal reflection and invective, which were never before known to mar the amicable adjustment of differences of opinion among American botanists. But this storm is likely to pass and leave the atmosphere clearer, brighter, and more invigorating; and it is to be hoped that no trace will remain of an interruption of good fellowship and general comradery which has heretofore distinguished the botanists of this country.

It is the broadened horizon for botany in general which makes the outlook for vegetable physiology so especially auspicious. This is the country of all others where its practical and educational importance is likely to be most fully recognized, and where the best equipped and most independent laboratories can most readily be established. One difficulty yet besets it, the difficulty of making known what is needed. Botany has not before required much more than a table near a window for its microscope and

reagents, a case for the herbarium, and a few shelves for books, and it is difficult to make it understood that the new department needs rooms with special fittings and expensive apparatus. If there were only one well equipped laboratory in the country, it might be cited as a model, but even that advantage is yet lacking. It can be explained that the chemical side of the subject needs much of the usual chemical apparatus and supplies with many special pieces, that the physical side requires similar provision, and that many pieces of apparatus are demanded which cannot be obtained in the markets owing to the newness of the subject, necessitating provision for making apparatus of both metal and glass; but the explanation rarely conveys a full appreciation of how essential and extensive this equipment is expected to be. In the fitting of the laboratory there should be rooms for the chemical work, with gas, water, sinks, and hoods, and rooms for the physical work, with shafting for transmitting power to clinostats and centrifugals, with devices for regulating moisture and temperature, and with as ample provision for light as in a greenhouse. There should also be dark rooms into which a definite amount of light may be introduced by means of arc lamps, and other special rooms for special lines of study. It is easy to see that a well stocked greenhouse is required to supply healthy plants when needed for study, but the value of a botanic garden may not be so apparent. It need only be pointed out here, however, that Charles Darwin examined 116 species of plants belonging to 76 genera to prepare his brochure on climbing plants, and it might have been more complete with greater opportunities.

The man who is to preside over a department of this kind, in which research work is to be carried on, and instruction undertaken suitable to a university, cannot be one of St. Thomas Aquinas's *homo unius libri*, for physiology touches upon the adjacent sciences to a far greater extent than do other departments of botany, and requires a more intimate acquaintance with a wide range of knowledge.

After careful consideration of the subject, it seems safe to predict that the next great botanical wave that sweeps over America will be a physiological one. As the green chlorophyll grain of vegetation is the great primal storage battery, absorbing and fixing the energy of the sun, and making it available for doing the

work of the world, — in fact supplying nearly all the power, except that from wind and water, required in commercial enterprise, whether derived finally from animal force, wood, coal, steam, or electricity, — so the subject which includes the fundamental study of a matter of such universal importance will without doubt eventually attain to a place in public esteem commensurate with its importance.

PAPERS READ.

VARIATION AFTER BIRTH. By Prof. S. H. BAILEY, Ithaca, N. Y.

[ABSTRACT.]

THE current discussions of the causes of variations are concerned chiefly with those forms which are congenital. The present paper designs to show that a given set of individuals starting equal may arrive at very unlike destinies and may impress these differences upon the offspring.

THE DISTINCTION BETWEEN ANIMALS AND PLANTS. By Prof. J. C. ARTHUR, Lafayette, Ind.

[ABSTRACT.]

ATTENTION is called to the present and former use of physiological characters to distinguish plants and animals and their insufficiency, and to the necessity of using structural characters. The following diagnosis is suggested: Plants are organisms possessing (in their vegetative state) a cellulose investment; animals are organisms possessing (in their vegetative state) a proteid investment, actual or potential.

[This paper will be printed in the American Naturalist for Nov., 1895.]

FUNGOUS GARDENS IN THE NESTS OF AN ANT (ATTA TARDIGRADA BUCKL.), NEAR WASHINGTON, D. C. By WALTER T. SWINGLE, Washington, D. C.

[ABSTRACT.]

BELT was the first to suggest in 1874 that the Central American leaf-cutting ants (*Atta* sp.), use the cut-up leaves they carry into their nests as a soil on which to cultivate fungi which, instead of the leaves, serve as food for the ants. Before Belt's careful observations it had been commonly supposed that the leaves were used for constructive purposes.

In 1893 Möller published a magnificent work on the fungus gardens of ants in South Brazil. He showed that not only did the species of *Atta* cultivate a fungus on chewed-up fragments of leaves, but that most remarkably they make a *pure* culture of a single species and that they prevent the fungus from producing conidia or other fruit forms. They cause it instead to produce groups of globular inflated hypha ends, which

are indehiscent and almost incapable of germination, but which serve admirably as food for the ants. Möller proved that they live exclusively on these "kohlrabis." The mass of fungus produces exceedingly abundant conidial fructification of two sorts if the ants be removed; as long as they are present only kohlrabis are formed. On rare occasions the perfect form of the fungus is developed — a new species of *Rozites* (*R. gonglylophora*, Möller). All four species of *Atta*, near Blumenau, cultivate the same species of fungus though *Apterostigma* and *Syphomyrmex*, two allied genera of *Attini*, both cultivate different fungi.

In July of this year I examined some colonies of *Atta tardigrada* which Mr. Pergande had found in the vicinity of Washington. The nests are small subterranean cavities, 6–10 cm. in diameter, situated from 2 to 15 or 20 cm. below the surface. Some nests have one cavity, others two. Almost the whole cavity is filled with a grayish material loosely and irregularly connected together. By watching the ants, it was determined that they carried into their nests the excrements of some leaf-eating insect, lying on the ground under neighboring oak trees. This same material was found to constitute at least a large part of the substance filling the nest. Even with a low magnifying lens, tufts of minute sparkling bodies could be seen on the fragments of the fungus garden, while the whole mass was interpenetrated by the white mycelium of a fungus.

Examination with higher magnification showed that the glistening tufts were really composed of "kohlrabi" even more perfectly spherical than any figured by M. Möller. The mature kohlrabi were very much larger than the mycelium below, being 22 to 52μ wide and 30 to 56μ long, while the supporting mycelial threads were only 4 to 8μ in diameter. There is no septa dividing the kohlrabis from the mycelial threads.

The whole appearance of the fungus is strikingly similar to that found by Möller, and it is by no means impossible that it will prove to be the same species though the kohlrabis are nearly twice as large as what he reports.

A living colony of ants with their fungus garden was exhibited.

ANTIDROMY IN PLANTS. By Prof. G. MACLOSKIE, Princeton, N. J.

[ABSTRACT.]

Two years ago I found that there are two kinds of maize, both produced by grains from the same ear, and one the reverse of the other in the overlapping of the leaves, in the spirality of the young leaves in the embryo and in the aspect of the grains on the very young ear on which they are borne. The diversity of the adult plants was found to depend on the place of origin of the ovules, which seem to take a twist in contrary directions. For this reason I call this habit *Antidromy*, adding that it is a primitive character, dominating the whole plant; and that it is common to all the Gramineæ.

I have now discovered that flowering plants are all, so far as I have

been able to examine them, antidromic. Of every species there appear to be dextrorse and sinistrorse individuals in about equal numbers; depending on the origin of the ovules being either from the right or left margin of the carpel. This character, being primitive, is in many plants disguised by twinings of stems, by spreading out of leaves to light, by secondary torsions of flowers, and by difficulty of orientating seeds. Thus, in some plants we detect it best in the phyllotaxy, in others in the inflorescence, and in some cases in the seeds. It is easily determined from the seeds of Bean, Almond, Coffea, Nelumbium, Corn; from the folding of the petals in Water-lily, from the inflorescence and phyllotaxy of Ladies' Tresses (*Spiranthes præcox*, Watson); and most frequently from the phyllotaxy, which is here revived in science with a new significancy. In a very large number of orders the phyllotaxy is dextrorse in one-half and sinistrorse in the other half of the individuals; and I think this the usual rule when not overturned by secondary changes.

Using these combined characters I have found antidromy to fail in no case thus far examined. (I have not yet examined the orders with opposite leaves; save that in Coffea the enfolding of the endosperm and the external forms of the akenes are antidromic.) The following orders have been all examined as to some of their species, with positive results,—*Berberidaceæ*, *Cruciferæ*, *Nymphæaceæ*, *Malvaceæ*, *Geraniaceæ*, *Leguminosæ*, *Rosaceæ*, *Onagraceæ*, *Rubiaceæ*, *Umbelliferæ*, *Compositæ*, *Lobelieæ*, *Borraginaceæ*, *Scrophulariaceæ*, *Convolvulaceæ*, *Nolanaceæ*, *Proteaceæ*, *Euphorbiaceæ*, *Salicaceæ*, *Cupuliferæ*, *Araceæ*, *Orchidaceæ*, *Liliaceæ*, *Musaceæ*, *Juncaceæ*, *Cyperaceæ*, *Gramineæ*.

Plants produced by cuttings or from bulbs retain the same kind of spirality, as if their several individualisms were only of a qualified kind. But I find that Aroids, Iris and Rushes, when grown by branching of a common root-stock, become antidromic, as if they were produced from seeds. This shows an unexpected peculiarity. In liquidambar the phyllotaxy varies as between different branches of the same tree. The diversity of seeds on opposite sides of the same carpel (easily observed in the bean-pod) suggests a curious kind of antidromic heredity, and this notwithstanding the apparent discontinuity occurring in the origin of the oöspore within the embryo sac. (Coffea shows seed-vessels as well as seed-coats and seed-contents taking part in this morphological duplicity.)

This law promises to be fertile in explaining puzzles, and often leads us to note peculiarities of parts which have hitherto been overlooked. I would suggest its use as a possible explanation of the splitting in different directions of timber belonging to the same species, a phenomenon which has been explained by some as caused by wind pressure on the growing trees.

ROOT FUNGUS OF MAIZE. By Prof. G. MACLOSKIE, Princeton, N. J.

[ABSTRACT.]

THE adventitious roots of maize, instead of ending in a suberized root-cap, have a club-shaped mass of soft, deliquescing cells, which on entering

the soil become a nidus for the luxuriant growth of a particular microscopic fungus. Other members of Gramineæ have a similar structure. Those parasitic or symbiotic fungi may possibly help to explain the ability of Gramineæ to extract nitrogenous food without impoverishing the soil.

RECORDING APPARATUS FOR THE STUDY OF TRANSPIRATION OF PLANTS. By ALBERT F. WOODS, Assistant Chief, Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture, Washington, D. C.

[ABSTRACT.]

DESCRIPTION of an automatic device for registering the loss of water by transpiring plants. The apparatus itself was used to illustrate the paper.

PRESSURE, NORMAL WORK AND SURPLUS ENERGY IN GROWING PLANTS. By GEO. M. HOLFERTY, Stud. Phil., Leipzig, Germany.

[ABSTRACT.]

General statements concerning:

1. Pressures,—interior and exterior.
2. Resistances,—natural and artificial.
3. Work-effects,—normal and extra.
4. Pfeffer's results showing amount of pressure.
5. Questions to be discussed.
6. The gypsum method and "pressure spring" for *root pressure*.
7. Table and platted curve to show:
   - *a.* Time of beginning.
   - *b.* Rate of progress.
   - *c.* Maximum.
8. The dynamometer and "pressure spring" for *stem pressure*.
9. Table and platted curve to show:
   - *a.* Time of beginning.
   - *b.* Rate of progress.
   - *c.* Maximum.
10. Comparison of the *normal work* (stem lifting its own weight) with the *extra work* (stem lifting lead weights).
11. Conclusions and general significance of the results.

NOTES ON THE NINTH EDITION OF THE LONDON CATALOGUE OF BRITISH PLANTS. By Dr. N. L. BRITTON, Columbia College, N. Y. City.

[ABSTRACT.]

A comparison of the treatment and nomenclature of genera common to Great Britain and northeastern North America.

OBOLARIA VIRGINICA L. A MORPHOLOGICAL AND ANATOMICAL STUDY. By Dr. THEO. HOLM, Assistant Pathologist, U. S. Dept. Agriculture, Washington, D. C.

[ABSTRACT.]

A GENERAL sketch of the systematic position of this plant, based upon the morphological characters, and the anatomy of its various organs with references to the same of other plants, especially saprophytes and parasites. The paper was illustrated by diagrams and alcoholic specimens.

[This paper will be printed in the Publications of the Division of Vegetable Physiology and Pathology, Dept. of Agriculture.]

BOTANY OF YAKUTAT BAY, ALASKA. By FREDERICK V. COVILLE, Botanist of the U. S. Department of Agriculture, Washington, D. C.

[ABSTRACT.]

A REPORT on a collection of plants made at Yakutat Bay, Alaska, by Frederick Funston in 1892, with a general account of the relation of plant life to environmental conditions and to native industries.

[This paper will be printed in Contributions from the U. S. National Herbarium.]

POISONING BY BROAD-LEAVED LAUREL, KALMIA LATIFOLIA. By FREDERICK V. COVILLE, Botanist of the U. S. Department of Agriculture, Washington, D. C.

[ABSTRACT.]

AN account of the poisoning of a Diana monkey in the National Zoölogical Park, Washington, D. C., through the eating of Kalmia leaves; accompanied by a résumé of our knowledge of andromedotoxin, the poisonous principle of this plant, prepared by Mr. V. K. Chestnut.

[This paper will be printed in a report of the U. S. Department of Agriculture.]

THE NUMBER OF SPORE MOTHERCELLS IN THE SPORANGIA OF FERNS. By WILLIS L. JEPSON, Assistant in Botany, Univ. of California, Berkeley, Cal. (Presented by GEO. F. ATKINSON.)

[ABSTRACT.]

DETAILS the investigation determining the number of spore mothercells in the sporangia of *Pteris cretica*, with comparisons of other species of Pteridophyta.

THE WATERMELON WILT AND OTHER WILT DISEASES DUE TO FUSARIUM. By Dr. ERWIN F. SMITH, Asst. Pathologist, Div. Veg. Phys. and Path., U. S. Department of Agriculture, Washington, D. C.

THIS paper notes:—

(1) The confirmation of statements made before this Section last year respecting the nature and cause of the watermelon wilt.

(2) The discovery of two additional stages of the watermelon fungus, making three in all, viz.: (1) Minute, elliptical, colorless conidia produced inside the *living* plant on white mycelium which plugs the water ducts; (2) Large lunulate, 3-5 septate conidia borne in great numbers on pale, salmon-colored conidia-beds on the surface of vines killed by the internal fungus; (3) Globose or oblong terminal or intercalary thin walled chlamydospores occurring on the surface of the wilted stems and also in tiny brick red masses in pure cultures on horse dung. 175 cases from soil infections. Disease just as readily induced by inoculating the soil with mycelium derived from an external, arcuate sharp-pointed, 5-septate spore 50μ long as by that from an internal, straight, narrowly ellipsoidal, non-septate spore 10μ long.

(4) Vitality of the fungus,—alive at end of ten months twenty-three days on dried out agar, and living in horse dung at end of eight months. Experimental proof that fungus lives over winter in the earth.

(5) Appearance of very brilliant colors—yellow, brown, crimson, purple, violet, etc. — when the fungus is cultivated on cooked starchy media free from alkali. On boiled rice, for example, it develops the most brilliant carmine and the substratum becomes intensely acid, but if a sufficient quantity of sodium carbonate be added the fungus remains pure white the same as it does in the alkaline contents of the ducts of the plant itself or on alkaline, meat-infusion, peptone agar.

(6) Discovery this year of serious wilt diseases in a number of other cultivated plants,—sweet potato, cabbage, cow-peas,—in all of which the disease is preceded by the appearance of a Fusarium in the water ducts of the plant, which in some way causes a decided *browning* of the same and followed by the appearance on the surface of the *dead* plant of conidia beds, bearing lunulate, 3-5 septate spores, indistinguishable from those found on the dead watermelon stems.

(7) Some account of Mr. Atkinson's cotton and okra wilt drawn from field studies in 1895, near Charleston, S. C.

(7) Discovery and description of *Nectriella trocheiphila*, a new ascomycetous fungus on wilted cow-peas, proof that the internal and external fungus are but two conidial stages of this ascomycete, and strong probability that the watermelon, cotton and okra wilt diseases here mentioned are due to the same fungus. (Since this was written the ascomycetous stage of the watermelon fungus has been discovered, and also that of the cotton fungus, and they are identical with that previously found on the cow-peas. The mature form has affinities both with *Nectriella* and *Melanospora* and appears to be an undescribed species. A full account will be

given as soon as cross-inoculations have shown conclusively that the three diseases are identical.)

[This paper will be printed by U. S. Dept. of Agriculture.]

THE SOUTHERN TOMATO BLIGHT. By Dr. ERWIN F. SMITH, Assistant Pathologist, Div. Veg. Phys and Path., Department Agriculture, Washington, D. C.

[ABSTRACT.]

THE more important points set forth in this paper and believed to be established are:

(1) Non-identity of the tomato wilt and the cucumber wilt.

(2) Identity of the tomato wilt and potato wilt.

(3) Susceptibility of various other *Solanaceous* plants, including the egg-plant.

(4) Cause of the disease, as determined by inoculations, a bacillus the biology of which has not been fully worked out, and a complete account of which has been reserved for a subsequent paper.

(5) The stinking *wet-rot* due apparently to one or more organisms that follow in the path of the true parasite.

(6) Primary infection of the plants, as a rule, through the parts above ground, and very readily obtained in the greenhouse by needle pricks from pure culture.

(7) In the potato, rot of the tuber follows infection of the foliar parts, and commences in the vascular system, *i. e.*, in that part of the tuber which is in direct connection with the stem.

[This paper will probably be printed as part of a Bulletin by U. S. Dept. of Agriculture.]

THE CONSTANCY OF THE BACTERIAL FLORA OF FORE MILK. By H. L. BOLLEY, Prof. Bot. N. D. Agric. College, Fargo, North Dakota.

[ABSTRACT.]

THIS paper is a report of a number of original investigations, bearing upon the point of the constancy of species and physiological types of bacteria present in normal fore milk. In general the evidence of the work, which was conducted upon the milk of ten different animals during three winter months and upon that of three animals during the month of July, is to the effect that species may be quite constant in the udder of an individual animal, but that there is but slight evidence of constancy amongst different animals, even under the same conditions.

A NEW CALIFORNIA LIVERWORT. By Prof. DOUGLAS H. CAMPBELL, Stanford University, California.

[ABSTRACT.]

ACCOUNT of a new liverwort allied to Sphærocarpus, collected near San Diego.

PERSONAL NOMENCLATURE IN THE MYXOMYCETES. By O. F. COOK, Professor of Nat. Science, Monrovia, Liberia (Huntington, N. Y.).

[ABSTRACT.]

OF the two systems of nomenclature, only the personal has been used in the Myxomycetes. This is illustrated by two recent monographs of the group. Of 41 genera and 430 species in Massee's "*Myxogastres*" only 33 generic and 160 specific names appear in Lister's "*Mycetozoa*." If, however, uniformity with the future is to be secured, the still more radical change necessitated by the application of the principle of priority should be made. Nearly all the genera established by Rostafinski must be supplanted by names disused for fifty years or longer.

It also appears that the oldest generic names were so employed that the usual method of application of the law of priority will necessitate that generic names be shifted from one family to another according as certain characters are looked upon as of greater or less importance. Thus there are three generic conceptions to which the name Physarum may be applied. This confusion can be avoided if we recognize the practice of considering the first species under a genus to be the generic type from which the generic name can not be separated.

[Printed in the Bulletin of the Torrey Botanical Club.]

AN EXOASCUS UPON ALNUS LEAVES. By MRS. FLORA W. PATTERSON, 29 Hammond St., Cambridge, Mass.

[ABSTRACT.]

THE paper notes the first recorded appearance of one of the Exoasceæ upon the leaves of Alnus in America. The material was collected in the Stony Brook Reservation of the Metropolitan Park system of Boston, Mass., June 17, 1895, by A. B. Seymour and F. W. Patterson. The fungus differs materially from *Exoascus Tosquinetii* (West.) Sadeb., *E. epiphyllus* Sadeb. and *Taphrina Sadebeckii* Johans., the European forms upon Alnus leaves.

The naming of the species is postponed until further collections may throw additional light upon its development and the extent to which the host is affected.

SUMMARY OF A REVISION OF THE GENUS DICRANUM. By CHARLES R. BARNES, Prof. Bot., Univ. of Wisconsin and RODNEY H. TRUE, Ph.D., Instructor in Pharm. Bot., Univ. of Wis., Madison, Wis.

[ABSTRACT.]

THE authors present a report upon the species of the genus, most of which have been critically examined; discuss the proposed new species

established by Kindberg and by C. Müller & Kindberg, of which seventeen out of eighteen are probably to be referred to already described species; and point out the species on which further light is desired.

ON THE ANALYSIS OF FLORAL COLORS. By Prof. J. H. PILLSBURY. Stoneham, Mass.

[ABSTRACT.]

DEMONSTRATION of the analysis of a number of floral colors on the basis of standards, proposed in another paper.

A LEAF-ROT OF CABBAGE. By H. L. RUSSELL, Ass't Prof., Bacteriology, University of Wisconsin, Madison, Wis

[ABSTRACT.]

DISEASE noted is a leaf-rot in cabbage that seems to be associated with bacteria although the author has not succeeded as yet in producing a recurrence of the disease by the inoculation of pure cultures of organisms isolated. The disease is first noticeable in the axil of the lower leaves in the sulcus on the upper side of the petiole. This depression is usually filled with moisture and the disease often gains an entrance at this point through the mechanical rents that are caused by the rapid growth of this succulent tissue Once within the cuticle, the rot spreads rapidly in the loose cellular parenchyma until it meets, in its course, the fibro-vascular bundles of the petiole.

This tissue evidently affords a better medium for the growth and spread of the germ, for the disease works its way rapidly through the length of the petiole by the way of the spiral vessels of the xylem.

In this tissue, the disease progresses rapidly, spreading out laterally at a slower rate so that the decay follows the course of the different bundle systems particularly those on the upper and lateral faces of the petiole. This materially interferes with the metabolic functions of the plant, causing a wilting of the affected leaves. The trouble so far has not proved to be very serious except during wet weather and where the plants were copiously watered by sprinkling. The progress of the malady can be easily arrested by cutting off the affected leaves close to the main stalk. This disease seems to be a different one than that described by Garman.

OBSERVATIONS ON THE DEVELOPMENT OF UNCINULA SPIRALIS. By B. T. GALLOWAY, Chief of the Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture, Washington, D. C.

[ABSTRACT.]

THE development of mycelium, conidia, and perithecia is discussed and the germination of the ascospores is described.

HISTORY AND PRESENT STATUS OF ORANGE CULTURE IN FLORIDA. By CHARLES PORTER HART, M.D., Wyoming, Ohio.

[ABSTRACT.]

HAVING resided during the past winter on a large orange grove in Florida, the author made a special study of the effects of freezing temperatures on the vitality of the Citrus family, especially of the orange and lemon, throughout the peninsula, together with the history and present condition of orange culture in the state, meteorological observations, and other matters pertaining to the subject.

THE EFFECT OF SUDDEN CHANGES OF TURGOR AND OF TEMPERATURE ON GROWTH. By RODNEY H. TRUE, Ph.D., Univ. of Wis., Madison, Wis.

[ABSTRACT.]

THE purpose of the investigation was to ascertain whether the fact of change in the concentration of the substratum or of the surrounding temperature, as such, influences plant growth. Radicles of *Vicia faba* were used as objects of study.

The sudden transfer of a radicle either from water to a one per cent KNO_3 solution, or *vice versa*, was found to produce a retardation of growth for various periods of time following the change. If a radicle was accommodated to the KNO_3 solution by a stay of two or three days in this medium, the transfer to water was followed by a much longer period of retarded growth than when the time spent in the KNO_3 solution was brief and accommodation had not completely taken place. That the retardation is due to the irritable properties of the plant is shown by the fact that when the change of medium causes a very material increase of turgor pressure, as is the case in the transfer from KNO_3 solution to water, the growth rate following the change falls below the normal rate characteristic for both water and the saltpeter solution. Growth and turgor pressure are, therefore, shown to stand in no directly proportional relation.

Similar results were found to follow temperature changes, the length of the retardation period depending (1) on the distance between the extremes and (2) in case of the transfer from low temperatures to a normal range, on the length of time spent at the lower limit. As a general rule, the lower the minimum limit or the more extended the time spent here, the longer the period elapsing before a growth rate characteristic of the higher temperature was assumed. Between temperatures near the maximum limit and a normal range, the few experiments performed gave similar results, it being understood that here the higher temperature acted in the same manner as the lower limit in the experiments previously referred to.

Immediately upon transferring a radicle either from 1° C. to 19° C. or

vice versa, a slight elongation or contraction was observed, originating in the purely physical phenomenon of turgor change in the cells due to temperature variation. This is governed by the same laws as gas pressure.

Thus it follows that change, as such, (1) in the concentration of the substratum and consequently in the turgor pressure, and (2) in the surrounding temperature, when sudden and extreme, acts as a shock to the irritable organism producing a more or less pronounced retardation of the rate of growth.

EXPERIMENTS IN POLLINATING AND HYBRIDIZING THE ORANGE. By H. J. WEBBER, Assistant Physiologist and Pathologist, Dep't of Agriculture, Washington, D. C.

REPORT OF COMMITTEE OF SECTION G.

Your Committee on Bibliography begs leave to submit the following report:—

The author's index to American literature has been continued throughout the past year with the coöperation of the editors of the Bulletin of the Torrey Botanical Club. Various difficulties arising in the course of that publication suggest to the committee the following necessary limitations to the contents. It is recommended therefore:

1. That all bacteriological, horticultural, and agricultural titles be excluded; but in any case of doubt the title is to be included.
2. That all references to exsiccatæ be excluded.
3. That all references to reviews be excluded.

The committee reports also that the journal index which it was hoped to begin in the past year has been delayed by the desire to coöperate with and obtain the benefit of the work of a similar sort about to be begun by the Boston Public Library. The committee expects that this will be published very shortly.

The committee has also made arrangements for the publication of a subject index of American literature. This is to begin with January, 1896.

The committee received a grant of $25 from the A. A. A. S., for the printing of the rules of citation and the expenses of distributing the same. The stereotyping, printing and distributing of nearly one thousand copies of these rules have left a balance of only $0.64 in the hands of the chairman. As a small additional expense will probably be incurred the committee recommends that the council be requested to grant $5.00 additional for the expenses of the committee. [The grant was made by the Council.]

C. R. BARNES, Chairman,
A. B. SEYMOUR,
N. L. BRITTON.

RESOLUTION ADOPTED BY THE SECTION.

RESOLVED that a committee of three be appointed by the chair to consider and report next year upon the needed improvements in the International Bibliography of Botany.

The chair appointed as the committee, Messrs. HUMPHREY, COVILLE and UNDERWOOD.

SECTION H.

ANTHROPOLOGY.

OFFICERS OF SECTION H.

Vice President.

F. H. CUSHING, Washington, D. C.

Secretary.

STEWART CULIN, Philadelphia, Pa., until Saturday. Afterward, W. WALLACE TOOKER, Sag Harbor, N. Y.

Councilor.

ALICE C. FLETCHER.

Sectional Committee.

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Member of Nominating Committee.

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The VICE PRESIDENT and SECRETARY, and S. D. PEET, R. G. HALIBURTON, WASHINGTON MATHEWS.

Press Secretary.

W. W, TOOKER.

ADDRESS

BY

FRANK HAMILTON CUSHING,

VICE PRESIDENT, SECTION H.

THE ARROW.

I.

ITS ANTIQUITY.

ONE of the most ancient of the things men have made is the arrow. There is no weapon the lineage of which can be unbrokenly traced further or to a simpler beginning. We have been apt to lose sight of this through associating as inseparable, alike in origin and use, the *bow* with the arrow. But I think it can be shown that the arrow had been perfected in well nigh all its parts, had attained rank as the chief weapon and one of the supremest possessions of man, and had given rise to a surprising variety of things and uses long ere the simplest bow had been conceived of or fashioned.

If this be true, then the arrow, in its ancestral or embryonic form at least, was as old as either the stone axe or the shaped knife of flint, if not older; was, in fact, coeval with the knotted clubs and rough stones men picked up at need in the wilds they earliest traversed; and we can see that through javelin and dart and harpoon it was sprung from the spear and lance, as they from the fire-sharpened pike, and this from the mere pointed stick—made sharp not by art, but by use—for digging or hurling, by turns.

II.

ITS INFLUENCE.

Again, there is no weapon and no single thing that for ages held sway so potent over the minds or the destinies of men, or wrought

more varied influence over their institutions and customs than did the arrow; for I think I can also make clear the fact that as it was the chief reliance and resource of primitive man in the two main activities of his life, war and the chase, it speedily became his first and ever remained, by representation at least, his highest instrumentality for divining the fate or fortune its use so often decided, and in this way came to affect, as no other single object of art ever did, the development and history of mankind in general the wide world over.

There is far more basis, then, than mere romance and beauty of comparison, for the poetic meaning of the arrow of literature, from biblical and classic allusions, to Shakespeare's own. "Jove's thunder-bolts" or "Cupid's darts," "Diana's arrows" or the "shining shafts" of Apollo, or of "Death" and "Destiny," were real arrows to the men of old time, for to them the love pang was an actual wound from a random and puny childish shot. The sharp pain of mortal throe or the slow anguish of fleshly ill was from a veritable stroke of the cold breath-sent shaft of ghostly foeman, or was the ceaseless rankling of some venomed barb of envious wizard or gaunt hungering demon.[1] The fire streak of the skies, the bright rays of the sun, the stinging flight of the sand-blast or hail-storm, and the sudden frost-bite—all of these were, indeed, to them the very counterparts and relatives of their own man-made but magically fashioned and feathered missiles. "Straight," "true," or "quick" as "an arrow," "sure as a shot," meant more to them than to us, for the force of such phrases never wore out so long as archers held their sway and men spake, like Homer's heroes, with "winged words."

III.

ITS RELATION TO ANTHROPOLOGY.

In presenting to you, then, a study of the arrow, I am not departing so far as might seem from the requirements of the high office you have so kindly called upon me to serve, for I would offer

[1] Thus the Zuñi name for a swelling is sho'lina (from *sho'ole*, an arrow, and *i'na* the content, the innermost element, quality, substance, or cause of a thing), and literally rendered means "arrow in it" or "arrow-caused." Thus, too, rheumatism is called by the Zuñis the "*sholiwe evil*" or "*disease of arrows*;" and in treating this malady their medicine men try, after due manipulation of the affected part, to pluck forth the misty arrows or barbs they suppose are within, with magical snare-wands of eagle-feathers, blowing lustily the while to cast out these poison-missiles and thus keep them from harming others or themselves.

something characteristic, not so much of a field, as of a method and standpoint of investigation which I believe to be peculiarly adapted to the needs of our science; and I would illustrate, and hope I can measurably demonstrate herein, how special lines may and should be followed to general, and as far as can be, to universally applicable conclusions, these tendered not dogmatically, but suggestively; that we may select, say, single phases and arts of humanity and even local manifestations of them, and should not only present, but study them, subjectively rather than objectively; not externally and categorically or as isolated phenomena, or as mere examples of racial similarities and dissimilarities, nor yet, primarily, even as to whence they came ethnically, but rather, as to how and why they became at all, and originally,—as illustrations, that is, of the laws and principles which have governed man's development under all sorts of circumstances and in every age and land.

It is in this spirit, at least, that I treat of the arrow; not as a weapon merely, not descriptively to any greater than needful extent, but in its relation to the history of man and his culture-growth; as an illustration equal to any, I believe, of how certain few human things and activities have been born (often so simply as to have been inevitable wheresoever man chanced to dwell), and of how they have grown, also very naturally and independently of at least deliberate devising, and in so doing have sometimes given rise to multitudinous other and diverse things and activities, thus profoundly affecting man's psychological as well as racial development, and hence contributing inexorably both good and evil lessons and influences to his culture everywhere, and everywhere similarly.

If, moreover, I am at times seemingly too personal in style of statement, let it be remembered that well-nigh all anthropology is personal history; that even the things of past man were personal, like as never they are to ourselves now. They must, therefore, be both treated and worked at, not solely according to ordinary methods of procedure or rules of logic, or to any given canons of learning, but in a profoundly personal mood and way. If I would study any old, lost art, let us say, I must make myself the artisan of it—must, by examining its products, learn both to see and to feel as much as may be the conditions under which they were produced and the needs they supplied or satisfied; then, rigidly adhering to those conditions and constrained by their resources alone, as ignorantly

and anxiously strive with my own hands to reproduce, not to imitate, these things as ever strove primitive man to produce them. I have virtually the same hands he had, the same physique, generally or fundamentally the same activial and mental functions too, that men had in ages gone by, no matter how remote. If then, I dominate myself with their needs, surround myself with their material conditions, aim to do as they did, the chances are that I shall restore their acts and their arts, however lost or hidden; shall learn precisely as they learned, rediscovering what they discovered precisely as they discovered it. Thus may I reproduce an art in all its stages; see how it began, grew, developed into and affected other arts and things—all because, under the circumstances I limit myself to the like of,—it became and grew and differentiated in other days.

If the subject be in paths somewhat different from this, as, for example, some portions of my present essay are, I shall also think of it as it related to primitive men in primitive state of mind. I would divine how the men of old felt about their arrows, and what, therefore, they did to them and with them. They were simple, like little children, given to looking on their favorite things as the children of to-day look upon favorite toys, with a vast deal of personal feeling, emphasized in their case, to huge proportions, by the tremendous part these arrows bore in their lives. They had no knowledge of physics to guide them. Analogy was their explanation of relations, and the dramatic interpretation of these relations and the phenomena thereof their only logic. And so, behold, the arrow was for ages looked on as a wand of enchantment to those who made and used and lived by and loved it; was to them a symbol—a veritable portion and potency of the mightiest forces and beings that they thought the world and four quarters, the sky, or the under earth held; was thus transcendent over the skill of their deftest archer; was a thing of magic, and was willful, as like to obey the wind-bird with whose feathers they had winged its shaft withal, the god in whose breath it wavered, as to obey themselves or him who wrought and loosed it; for itself would decree his luck or his fate, not he who sped it, else why all so vainly at times, however great his skill or his effort, did he speed it? Therefore it played as large a part in their theoretical and mythical as in their practical life, and must be theoretically and imaginatively, no less than practically and experimentally, studied.

IV.

MY DISCOVERY OF ARROW-MAKING.

I tell you in detail, then, how, through making many arrows, I have studied the arrow and its development practically; how, by using it unweariedly and consorting long with those who used it actually with natural purpose and method, as well as by pondering deeply upon it in the most primitive moods I could muster, I have studied, theoretically, too, its meanings and relations; the place it held in men's hearts and minds ere ever they knew of goodlier friend or deadlier foe.

When I was a boy less than ten years of age, my father's hired man, while plowing one day, picked up and threw to me across the furrows a little blue flint arrow-point, saying: "The Indians made that; it is one of their arrow-heads." I took it up fearfully, wonderingly, in my hands. It was small, cold, shining, and sharp—perfect in shape. Nothing had ever aroused my interest so much. That little arrow-point decided the purpose and calling of my whole life. It predestined me, ladies and gentlemen, to the honor I have in addressing you here to-day, on arrows; for I have studied archæology far more, alas! than anything else—ever since I treasured that small arrow blade on the lid of an old blue chest in my little bedroom, until the cover of that chest was overfilled with others like it and with relics of many another kind.

I was fortunate enough, not long after, to find in a neighboring field a place where some of these blades had been made. I could see that they had been fashioned in some way by chipping, for the scales lying there were like those I had been wont to strike off to see the sparks fly. When, in course of time, I had gathered a collection of some hundreds of relics from all over central and western New York, I began a series of experiments to learn how these arrows had been made. No one could tell me, and I had no books on subjects of anthropology then.

There was a farmer in our neighborhood, who, when young, had gone to California. It was in the days of "Forty-nine," and he had been pricked in the shoulder by an Indian arrow. He may not have killed the Indian, but had, at any rate, his whole sheaf of arrows—quite as perfect a set as I ever saw. They were all pointed with obsidian tips, like mine in shape and finish, but smaller. In

recognition of my passion he gave me two of them. I thought the points were of glass, and forthwith added all the thick pieces of bottle-glass and window-plate I could gather, to my store of raw material for practice. With this I worked, now and then, throughout a whole season, but the products of my hammerings, though fair, were but crude compared with those of the field.

When nearly fourteen years of age I discovered in the woods south of Medina, New York, an ancient Indian fort. I built a hut there, and used to go there and remain days at a time, digging for relics while the sun shone, and on rainy days or at night in the light of the camp-fire, studying by experiment how the more curious of them had been made and used. One evening I unearthed a beautiful harpoon of bone. I had a tooth-brush. I chopped the handle off and ground it down on a piece of sandstone to the shape of the harpoon blade, but could not grind the clean-cut barbs in its edge. I took my store of flint scales and set to work on it, using the flint flakes in my fingers, or clamping them between split sticks, saw-fashion. The flint cut the bone away as well as a knife of steel would have cut it, but left the work rough. Now, in trying to smooth this, I made a discovery. No sooner had I begun

FIG. 1.—Experimental flint-chipper of bone.

to scrape the bone transversely to the edge of the flint than the bone began to cut the flint away, not jaggedly, as my hammer-stone would have chipped it, but in long, continuously narrow surface flakes wherever the edge was caught in the bone at a certain angle. I never finished that harpoon. I turned it about and used it as an arrow-flaker by tying it with my shoestring to a little rod of wood for a handle and pressing it at the proper angle to points on the flint which I wished to remove. I made arrow after arrow thus, in the joy of my new discovery, until my hands were blistered and lacerated, in one place so deeply that the scar remains to this day, and, worn down to a mere splinter, I still preserve my first tooth-brush flaking tool (Fig. 1).

I did not know at that time that archæologists the world over were ignorant, as I had been, of just how flint implements had been made, and I did not learn until my now so lamented friend, Pro-

fessor Baird, called me to the Smithsonian Institution, in 1875, that I was the first man, or rather boy, of our day who had practically discovered how to make implements of glass and flint flaked from side to side, and in this indistinguishable from those made by primitive peoples.

I have told this history as it occurred for a three-fold reason: first, to instance the manner in which I discovered flint-flaking, by chancing all ignorantly to follow precisely the course primitive men must have necessarily followed when, and as soon as with the hardest and sharpest stone they could get, which was fractured flint, they tried to scrape and fashion bone or horn; secondly, to convey to you the lesson this boyish experience taught me—that I could learn more by strenuously experiencing with savage things and arts or their like than others or I could have learned by actually and merely seeing and questioning savages themselves about such things and arts. Long before I went to the Smithsonian or lived in Zuñi I had elaborated from the simple beginning I have chronicled here, some seven or eight totally distinct methods of working flint-like substances with Stone-age apparatus, and subsequently have found that all save two of those processes were absolutely similar to processes now known to have been sometime in vogue with one people or another of the ancient world, and I confidently look to finding that the other two, and yet additional methods since experimentally made out, were somewhere followed by men before me. And, thirdly, there is another lesson of later development this experience has taught me: that palæolithic man, of the French caves at least—that man who is said to have known no other art of working stone than by rudely breaking it into shape by blows of other stones—could not have existed in such primary status of art for more than a few seasons at most; for even the casts of these cave remains that I have seen show carvings in bone and reindeer horn finished to such nicety and cut so elaborately that, with the splendid true flint of Europe, experience in making any one of them would have given birth to the wit of making and applying a hundred flaking tools. As might be expected, therefore, I find among the casts of the French cave objects in our National Museum and in the University of Pennsylvania several fine and well-worn flint-pressers, a flaker or two, and reproductions of even one knapper of horn, and all these things are polished with art as of polished stone.

V.

THE TYPICAL ARROW.

Before I briefly relate and show how arrows of the ancient world were made I must need describe them, but not in all their variety and detail.

Those of the American Indian are, as a whole, fairly representative of all others, and to the student who would become familiar with the characteristics of nearly all classes of these, I would recommend that most excellent and admirably illustrated "Essay on North American Bows, Arrows, and Quivers," written by Dr. Otis T. Mason and published in the Smithsonian Report for 1893, to which I am myself so much indebted.

You are all familiar with the toy and target arrows of our time, but you may not be aware that all toys, wherever found, with the slight exception of but a few very modern and mongrel mechanical devices, are survivals of either the weapons and utensils or else of the religious paraphernalia of antecedent times, and that this familiar arrow of the archery clubs is no exception to the rule, but is an excellent representative in all essentials, save only for its blunted pile, of the arrow that won our preëminent place in the world—the arrow of the Norman Conquest, of Cressy, Poitiers and Agincourt, of old England's matchless bowmen. But still it is not quite typical of its prehistoric kind.

The arrows of the Age of Stone may be best represented, I think, by one of their most highly developed forms—that of the famous Cliff-dwellers of the southwestern cañons, for in this we find combined the features of nearly all other kinds. In that matchless collection of very ancient remains from the cliffs gathered by the Wetherell Brothers and the Jay Smith expedition and now owned by Colonel C. D. Hazzard, of Minneapolis, which is on exhibition, I am happy to say, in the Museum of University of Pennsylvania, are many specimens of this arrow (Fig. 2). They are from thirty inches to nearly a yard in length; are tipped with delicately flaked, diminutive points or piles of chalcedony or obsidian. Some are barbed and tanged; others are merely triangular; but each is set into a nock or deep notch at the point of a tapering, hard wood fore shaft, and firmly attached thereto by alternate cross-wrappings of sinew. The fore-shafts are about half as long as the shafts or steles, which consist of medium-size reeds or canes, and are fitted

with shoulders, thence tapered sufficiently to be let into these slightly smaller ends three or four inches—far enough to rest against the stop or septum of the first joint—and are held in place by a seizing or binding of sinew around the shafts at the points of insertion.

The steles or bodies of these cane rear-shafts are some of them grooved with long, straight, or wavering lines, and are not only winged at the shaftments or base ends with feathers, but are also footed—that is, the extremities have been split slightly at four, sometimes only three, equidistant points, and plugs of wood have been set into them and bound in place by sinew to receive the nock for the bowstring, somewhat as strips of hard wood are let into slots of our spruce target arrows to keep them from splitting when drawn or loosed. Each of these arrows is winged with three half-plumes, mostly split from the first six pinion feathers of eagles or falcon (for they happen, with one or two exceptions, to be war arrows), which are laid equidistant along the shaftment the length of one's palm and forefinger down to within an inch, more or less, of the footing, and seized at the ends with sinew and glue. One of the plumes of each arrow, called the "tail" by the Indians and the "cock feather" by the old English archers, was placed so as to stand out exactly at right angles with the nock of the arrow, and, as I shall presently show, was most significantly tufted and notched, primarily to denote that it was to be uppermost when the arrow was nocked, so that neither of the opposite feathers or "wings" should touch the bow when the arrow was loosed from the string.

Finally, around the shaftment, between the feather-seizings bands or ribands of color were painted, red and black, chiefly, and variously disposed, also most significantly, as we shall soon see. Arrows of the kind I have just described are

FIG. 2.—Foreshafted reed arrow of ancient Cliff-dwellers, showing tip, foreshafts, and footing-plug insertions.

called "compound." Arrows with shafts made from single rods of wood are called "self" arrows, and, strangely enough, although apparently simple, they more often than not have tokens of derivation from the compound kind, and the successful making of them was much more difficult.

VI.

THE MAKING OF ARROWS.

As shown by my experiments of many years, by the scattering allusion of travelers, and, more than all, by my life with an archaic, very archaic, people, the steps in the manufacture of arrows, of their points of flinty stone, which men of primitive days most widely followed, were few and simple, yet exceedingly curious and ingenious.

They first sought the material, mined it arduously from buried ledges with fire, mauls, and skids,[1] or, preferably, when the country afforded, sought it in banks of bowlder pebbles, digging such as were fit freshly from the soil, if possible, and at once blocking out from them blanks for their blades by splitting the pebbles into suitable spalls, not by free-handed percussion, but by holding them edgewise on a hard base and hitting them sharply and almost directly on the peripheries, but with a one-sided twist or turn of the maul or battering-stone. With each deft stroke (Fig. 3) the spalls, sometimes twenty from a single cobble or block of moderate size, were with almost incredible rapidity trimmed to the leaf-shape basis of all primitive chipped tools by knapping them with a horn, bone, or very soft, tough, granular stone hammer mounted in a light handle. For this the spall was placed flatwise on the knee or on a padded hammer-stone, so called, and held down by the base of the thumb of one hand (Fig. 4) and rapidly struck along the edge transversely

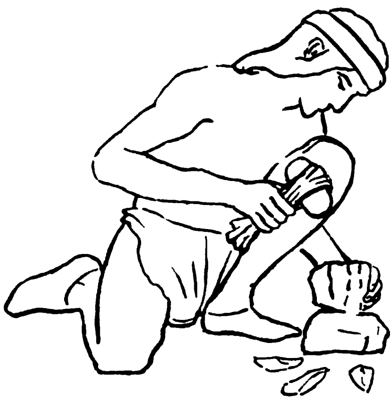


FIG. 3.—Splitting spalls or flakes from mass for blade-blanks.

[1] The reader is referred to the various masterly essays on this subject by Mr. Wm. H. Holmes and one by Mr. H. C. Mercer.

and obliquely to its axis lengthwise, with the outwardly twisting kind of blows used in the splitting. The blanks thus formed were then carried home for leisurely or opportune finishing, and carefully buried in damp soil, not to hide them, as has been usually supposed, but to keep them even-tempered or uniformly saturated ("full of sap and life," these ancients thought); whence the so-called "caches" of numerous leaf-shape blades which are now and then found, for example, throughout old Indian ranges.

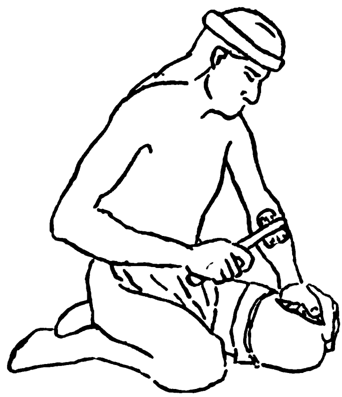


FIG. 4.—Knapping or shaping blade-blank from spall.

In finally forming arrow-points from these trimmed blanks, the smallest of them only were chosen. The first care in fashioning one of these was to remove protuberant points from its edge and sides and to thin it down by means of a pitching-tool of buckhorn. This was effected in several ways, usually by clamping it in a folded pad of buckskin under the knee against a hammer-stone or notched wooden block, so that the projecting edge rested over the margin or else over the pit of the stone, or notch if a block or log were used, and

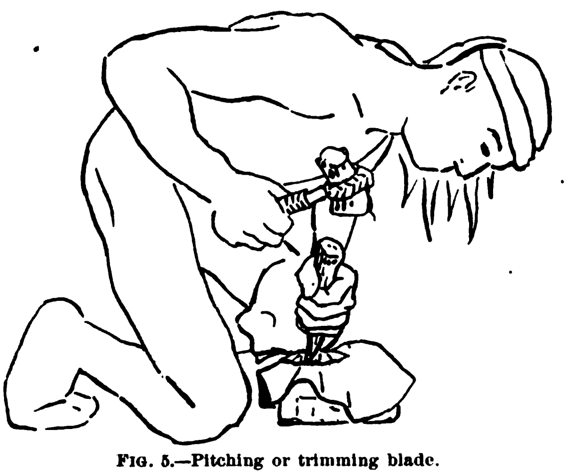


FIG. 5.—Pitching or trimming blade.

with one hand holding the point of the pitching tool very lightly and slantingly and at a wide angle, against or just over the points to be chipped, sharply tapping the tool with a maul or with a knapping hammer (Fig. 5). Thus the blade was quickly thinned

down and made almost even-edged. It was now further shaped, sharpened, nocked, or barbed or serrated, according to intended use, and tanged, with a rounded, flat bodkin of horn (seized to a stick or handle for leverage at one end and tapering therefrom to a curved, blunt point), either by laying it on a folded buckskin, over the hollow of a hammer-stone (Fig. 6) or the palm of the left hand, pressing it downward along the edges at nearly right angles, and always slantingly to its length, or else by holding it edge up between the thumb, and all the fingers of the left hand and freely flaking it, with the rod held in the right hand (Fig. 7), with handle braced against the ribs for steadying, by pressing the sharp edges until they caught in the point or blade of the bodkin, and twistingly wrenching them off by a most dextrous motion, which I can exhibit, but not adequately describe or illustrate.

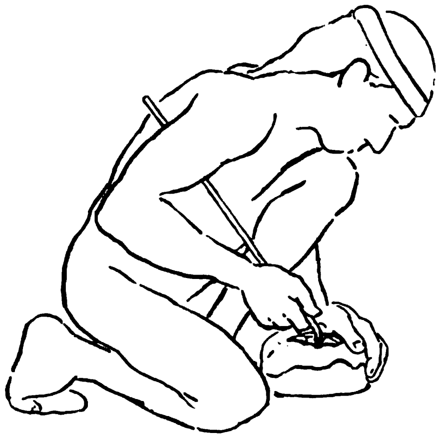


FIG. 6.—Chipping by downward pressure.

All this sounds complicated and tedious, but I have succeeded, from the time I found a suitable pebble of fine-grained, ringing, cold and fresh quartzite, in making seven finished knife and arrow blades in exactly thirty-eight minutes, and I have often made from obsidian or glass a very small and delicate arrow-point—the most easily made, by the way—in less than two minutes.

FIG. 7.—Chipping and nocking by cross pressure or wrenching.

When a number of the points had been finished they were warmed by the fire and rather ceremoniously enwrapped in buckskin or fur, not more to keep them safe than to " cure " them of all this rough handling and win them to favor and strength; for by the very clink of the perfect ones it was known now that they were full of life, each of its own—the life and fire of the lightning, which could be seen at night when they were rubbed or struck against one another or ground on a sharpening stone.

When war work was impending these old-time artisans or fletchers went forth "sprout making and cane-cutting," as they called their gathering of reeds and twigs; or, when later, as the Pueblos did, they abandoned the compound arrows of their ancestry and

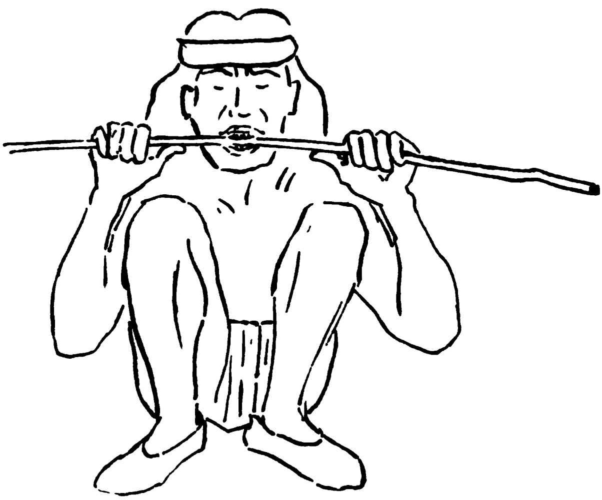


FIG. 8.—Shaft-biting for preliminary straightening.

took to horse and short bows, they called it "cane-sprouting" when they gather, all green, their shaft twigs, or "browsing" when they designed them to serve for the chase. These twigs were cut with due sacrifice to the wood sprites, were brought in head or upper ends foremost, passed over the store of points to make them acquainted, and laid down with their tip ends to the east or south if for the peaceful hunt; to the west or north if for war. They were peeled upwardly, or from butt to tip, that their way of working be not balked; scraped and shaved to uniformity, also from the butt upwards, and placed alongside a hot fire or buried in moist, hot sand to soften or " ripen " them; and then, after being bitten straight

in the most crooked places (Fig. 8)—it did not much matter how crooked they were at first—each in turn was clamped between one nether, grooved piece of sandstone or sanded wood and one small flat piece held over it firmly in the left hand, and was shoved and pulled twistingly back and forth until smoothed and rounded and further straightened (Fig. 9). Finally, each was both seasoned and polished, then straightened to a nicety by passing it, under heavy pressure, over a smooth grooved piece of very hot soapstone, or else, better still, by heating it and "stretching" it through a veritable draw-plate of bone, horn, or hard wood (Fig. 10) furnished with a single medium hole or with several beveled perforations. While being stretched the shaft was wrenched with a quick turn here and

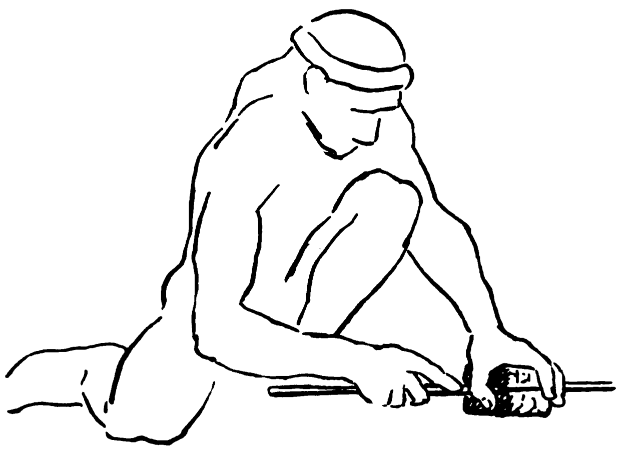


FIG. 9.—Shaft smoothing by grinding.

there at remaining crooked places, then smoothed down by additional and gentler stretching, that it might be coaxed to keep straight. When fully stretched, it was grooved along three or sometimes four places on its circumference with the tusk of a puma or wild cat (of fiery eye) if for war; with elk, beaver, or other gentler kind of tooth if for the peaceful chase. With the point of this tooth the shaft was pressed alongside of the stretching plate as it was being finally pushed through from tip to shaftment place (Fig. 11) or feathering point—twistingly for at least every alternate groove—that a wavering trail might be made for the lightning to traverse from point to quill when the feathers whistled, speeding the sure flight of the arrow.

The shaft came forth from this operation lengthened considerably,

polished, groove-marked, straight in the main, but bent perhaps along its full length. If so, it was warmed along the inner curve of the bend, held, tip outward, in the left hand, the butt grasped by the right (Fig. 12), and was bent a little this way and that till true, held so a moment, and laid down close to the fire, where it speedily dried to rigid straightness, until perchance rained on. The shaft was nocked at the lower end first by notching it deeply with a flint sawed across (but more or less with) the grain and by rasping out the bottom of the notch with a blunter-edge knife or sanded string and by heating, and spreading the flanges thus formed with a rib or other hard edge or with a hot stone. If a split appeared or was likely to appear, the foot was whipped with sinew.

FIG. 10.—Shaft "stretching" or final straightening with draw plate.

Now it was ready for feathering. Three pinion feathers, all from the right or all from the left wing of eagle, hawk, or turkey were chosen and cleft from tip to base by splitting and pressing the quill apart along its inner groove or midrib. The featherings were all chosen from corresponding sides of the midrib, that they might be uniform. The pith was scraped out of

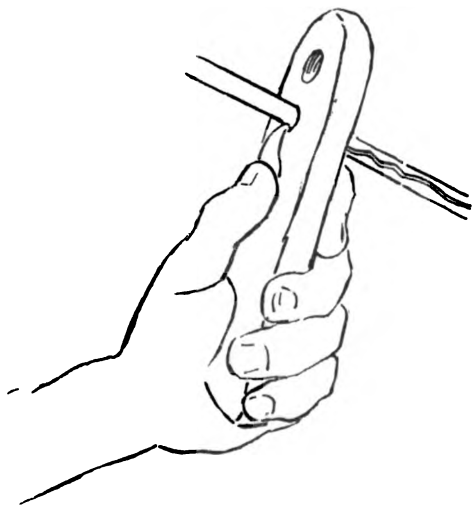


FIG. 11.—Shaft grooving with tooth and draw plate.

the lower parts of the quills until they were thin and flexible, and the edges of them were pared away. They were now laid flat along the shaftment, the bases of the quills toward the tip, first the right-wing quill, then the left-wing quill, so called; finally the tail quill; the latter transversely to the nock to serve as a cock feather.

All were seized on with filaments of mouth-moistened sinew, one end held in the teeth until a turn or two of the wrappings had been taken to keep the feathers in place. Then one end of the shaft was held under the left arm, the other between the thumb and forefinger of the left hand (Fig. 12 a b, *a*). The thumb and the fore and middle fingers of the right hand were moistened, and with them

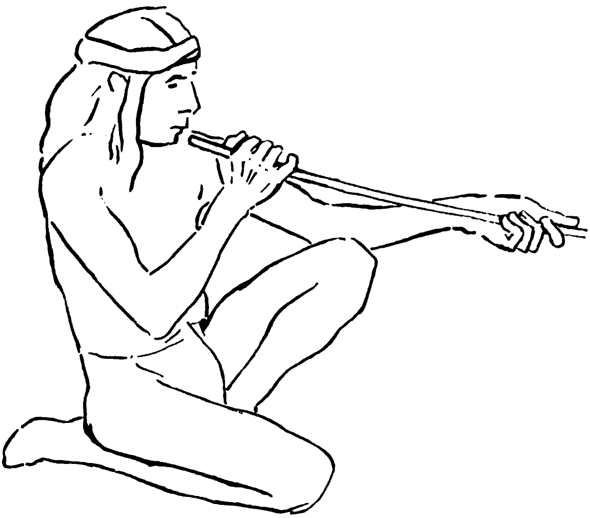


FIG. 12.—Shaft-truing.

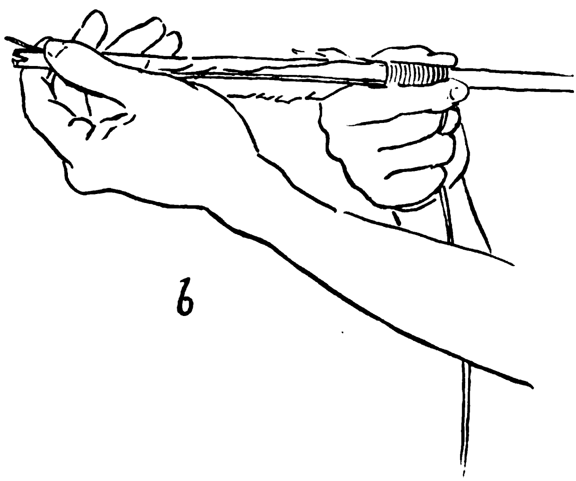
the shaftment grasped over the first wrapping. The sinew filament was drawn taut and held so between the middle, little, and ring fingers and the edge of the palm, and the shaft rapidly twirled with the thumb and fingers of the left hand (Fig. 12 a b, *b*). Thus the bindings of sinew were pressed flatly and tightly on as it was wrapped, and, being moistened and very fine at the ends, adhered without further fastening.

Now the lower ends of the featherings were similarly fastened, some of the pluming or alæ being usually seized on together with the quill to strengthen and tuft it, and the plumes being stripped down once or twice spirally with a double motion to make them lie

flat, were finally pulled through at the ends to straighten them, and flatten them still more.

After all the shafts had thus been feathered the whole bunch was

a



b

FIG. 12 a b.—Feathering and seizing; *a*, position in holding; *b*, of fingers in twirling and binding.

taken in hand, the butts struck against the ground or a stone, then reversed and righted, and with a puff of the breath thrown down, ends forward. According as the arrows rebounded and fell, they

were carefully sorted into groups, and with the more highly developed tribes, like the Zuñi, the cock or tail feathers of each group were notched, trimmed, and tufted differently from those of the other groups, to denote their classes as being, one set of the north, another of the east, and the others, respectively, of the south and west. The top and midmost shaft was reserved as a personal arrow for special treatment, and the doubtful shafts were left unfinished. At last, in correspondence to the kinds of shafts as indicated by the cock feathers, the points were selected, the keenest and deadliest for the north and the west, the broadest and shortest for the south and the east. The tips of the shafts were nocked and rasped, each with the base of the point designed for it; and the points were then seized on free-handed with sinew, as I have described heretofore. All these increasingly solemn operations were concluded by the orderly ribanding of the shaftments with the colors of death and blood—black and red,—or with the yellow of magic, or the green or blue, of life and victory.

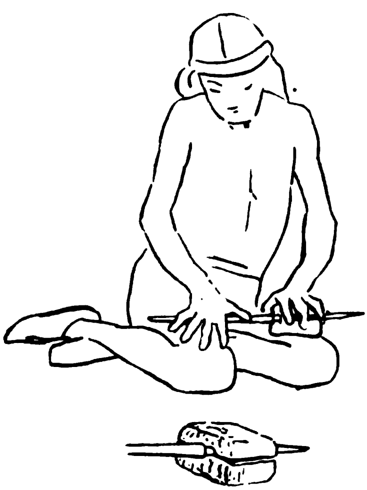


FIG. 13.—Turning or chamfering of fore-shaft.

The arrows were finally laid out to the west or to the east and breath-endowed with lives of their own; then placed with their parent, the fire arrow[1] (all save its consort, the personal one), in their quiver, heads downward, feathers upward, that the lightning run not out nor the feathers speak before their time, but sleep till wakened for war council and "feeding" or medication.

I find evidence that the Cliff-dwellers followed much these same methods, save that the fore-shafts were made differently, and the

[1]This was not always an arrow, properly, but a shaft carried ever ready for use as a fire-stick or drill, in the quiver. It was usually, however, made from a well-tried arrow, and was called fire-reed or arrow, by the Zuñi. I am assured by that distinguished Arabic scholar, Dr. Talcott Williams, of Philadelphia, that such must have formerly been the practice of the Arabs, for he finds that their terms for arrow and fire-stick are likewise similar.

order of proceedings, as evidenced dingily by traces on these old-time shafts, inspected in old-time mood, was accordingly different.

The fore-shafts were, for instance, tapered and rounded, chamfered, and the shoulders cut on them all by twirling (either with the fingers or with the hand on the thigh) between gritty stones (Fig. 13)—as early a kind of lathe-work as I have learned of this! Moreover, before the cane-shafts were grouped to the four quarters and the points chosen for them, the tips were fastened to the fore-shafts, as belonging to them,—being their shanks. This and many other interesting, highly significant details, I have made out; how, I cannot pause to relate, but with Zuñi lore and language, as well as reason, on my side.

Nor is there time for analyzing all of these customs and explaining how many of them are survivals of originations so practical and simple withal that they must have been measurably similar and universal in given conditions of culture-growth; but it may be well for me to explain that, being survivals of ages and successions of experience, we must eliminate one after another, the more elaborate of them as we think backward in time; that we must do the same with the working processes I have been earlier describing also; and if you will bear with me during a few moments more of detailing, I will try thus to lay bare not all the stages in stone-working and arrow development, but what seem to me to have been their primal beginnings.

VII.

ORIGIN OF EARLY ART AND OF LANCE-FORM TOOLS.

In a series of lectures given last spring at the Drexel Institute of Philadelphia, and in other papers, I have brought forward some of the many reasons which have induced me to suppose that man began his art development—his really manual and therefore mental and human development—on the coast of the sea of some tropical or temperate Old-world land. I cannot enter into the matter here much farther than to state that this human ancestor could not well have developed the habit of erect walking until forced from his earliest arboreal habitat and compelled to fend for life with his own hands, and thus taught to use them more for seizing and doing than for climbing and merely clutching, and thus also taught by his hands to devise, and with them to devise purposefully.

Now, in this period of transition from forest to open, from a

condition all but as artless as that of the higher tree-dwelling Quadrumana to a condition demanding rudimentary art at least, man could not have subsisted, it seems to me, in any other environment away from his fruit-giving trees, than near to the food-teeming sea, which, in dry season and wet, in cold and in warmth, ever abounded in easily taken creatures and things edible. The universal craving or liking man has for salt—especially with his meat food—would seem to point to some such profound and primal experience-period of the race as that. The well-nigh universal association of the sea-shell with fire ceremonials, would indicate that thus, too, on the coast of the sea he first learned to fear fire little enough to capture and keep or carry in shells, its seed or young; to loose and feed them, for protection at night, and from cold, and thus also to use them—the all-devourers—for half eating for him, food else too tough, too cold, or otherwise too hurtful for his eating. And, finally, the universal distribution of our kind coastwise, it would seem, the whole world over, ere ever language even had been developed vocally from hand usage and gesticulation far enough to remain steadfast or undifferentiated structurally in every great continental area, would also, along with much evidence of the arts, not least of them the arrow arts, still more strongly evidence the same sort of thing.

We can readily enough conceive that it was on the old ocean shore man learned to crack food things—shell-fish and bone—against the convenient stones of the beach; then to crack them with stones, and thus to crack stones against other stones in order to make them in turn crack these food-things the better, and at last to crack such cracking-stones with other stones, wherein he became a tool-making creature—that is, used tools with which to make other tools or with which to imitate and better mere use-made tools; and this was, and here ended, his *true* palæolithic period.

It was there, too, in the soft sand or mud of the seashore, that we most naturally think he learned to dig (for shell-fish and the like) with sticks, wearing them sharp thereby, and thus learning also to wear them sharp intentionally, in order to make them sharp; and from prodding the sand away from his food, it was but a step for him to prod his fellows—or anything else that stood in the way of his food—and thus-wise would begin the development of the pike, the lance, and the spear; the harpoon, the dart, and the arrow. The seeming likelihood of all this would lead me to linger yet a

little longer by the seashore with my earliest man. Moreover, I think I can thus explain better than elsewise quite other things about the arrow than merely its beginning, and can perhaps make it evident that I am not so fanciful as would seem, in this speculation.

First, as to the stages of tool and weapon making, there are three examples of the way in which awkward-handed, experienceless-minded beings began making (or, rather, using) things as tools. They are to be found in the acts of monkeys, imbeciles, or very young children. I have watched and experimented with all three studiously and long. If they would break a thing, they cannot—or at least they never do—dissociate the thing to be broken from the breaking of it. They hit it against something bigger. My friend, Thomas Eakins, the Scientist-artist, of Philadelphia, has a pet monkey named Bobby. As Mr. Eakins is honoring me by painting my portrait, I have had opportunities for observing Bobby. Now, if you give Bobby a large, hard nut that teeth will not crack, he instantly looks about for a stone or other hard object (he one day chose—literally hit upon—my head) and proceeds to maul the nut against it until broken. Although his master has surrounded him with convenient stones and sticks, he never uses them against the nut, but ever the nut against them, and if his curiosity be aroused as to any one of the nut-like stones, he hammers belike this stone against another, until it—not the stone he hammers—is broken; or if, accidentally, he breaks the stone he is hammering upon, he gains no lesson therefrom, but promptly seeks another stone on which to hammer the one he would break.

Very little children, if untaught or non-observant, do things in this way, and as far developed as the Tasmanians were above this stage of art, they still practised edging their hard pebble-choppers (Fig. 14) by seizing them with both hands—the more accurately to direct them—and whacking them until chipped sharp obliquely against other stones, and in this they were, but a few generations ago, in the true palæolithic period of their development.

FIG. 14.—Outline and section of Tasmanian chopper-pebble.

There are also three contemporary examples of the early use of a prod as a weapon—of at least the chase. These are: Bobby again, young children, and (I say it not gracelessly) women trying to drive chickens or cattle or other frightful creatures. Bobby hates a certain too curious cat, and is not sufficiently scared by her to fear showing fight whenever she appears. If the cat happens to steal near, but keeps beyond the reach of his tether, he does not throw a stone at her; but he has a long stick with which he hauls things toward him when put beyond his reach and with which he scratches them up when they are buried near by. While it never occurs to him that he can reach the cat with a stone by hurling it at her, yet he tries to reach her with the stick by lunging it at her. He has thus learned that if he cannot punch her in this way, nevertheless he can hit her, and educe the desired and delightsome squall by lungingly hurling it at her, and he does this now with increasing skill and frequency; never by actually throwing it, but by lurching it forward with both hands, and as much with the body as with the hands and arms. If you ever see awkward women or children after anything with a "sharp stick," you will observe that they throw it, if they cannot catch up, in much the same fashion—lurchingly, not overhand, as a spear should be thrown, for that would discontinue the initial movement.

And now, I will trace the arrow up from this lowly and slow-paced infancy, to his manhood and marriage with the home-staying bow, for whom he has ever since so swiftly obeyed and run errands.

VIII.

DEVELOPMENT OF THE ARROW-FORM MISSILES.

From such breaking of shells, stones, and bones such as I have characterized, and much cutting of his fingers thereby, primal man must have learned speedily enough to do all sorts of cutting, scraping, and scratching with the sharp fragments thus produced. For long, however, he probably used these fragments unmounted, grasping them, perchance, with wads of seaweed or grass; or, when large, winding or clasping them in wisps of fiber or rolls of integument for holding, as I have grasped the stone here exhibited (Fig. 15), with a fold or two of buckskin, in making with it the shaft-polishers and other like tools I have needed to use in my recent experiments for these demonstrations.

But by lodging such blades in wood or often wedging sharp things

into the end of his pike-form digging stick, he must have learned in time that the stick, so long as thus armed, dug better (and cut his contestants or his prey better, too) than ever merely with its wooden tip, no matter how well seasoned by heat or favored by long-tried use this was. Then he tied or otherwise attached suitable chips to his digger, which he may have sharpened in the old way—at the other end (Fig. 16)—as the Tasmanians used to, but which we may imagine he now shortened—having more of use for its peaceful than for its offensive purposes[1]—until, at need for the capture or the fight, he got a reed from the seaside rivers or marshes, straight and long and light enough to punch withal or fling, if it but had a point, and mounted his stone-bladed picker in one of its hollow ends, thus again lengthening it, at will. Lo! the fore-shafted spear, twin-changeling of the shaft-handled dirk and knife! Thus was born, with many another first form of the things we use, the ancestor alike of the retrieving arrow and of our familiar pocket

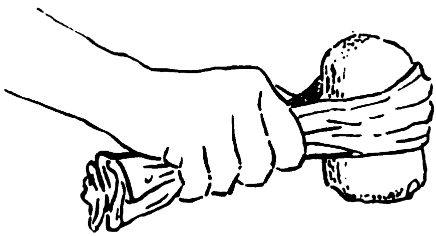


FIG. 15.—Makeshift haft of hammerstone.

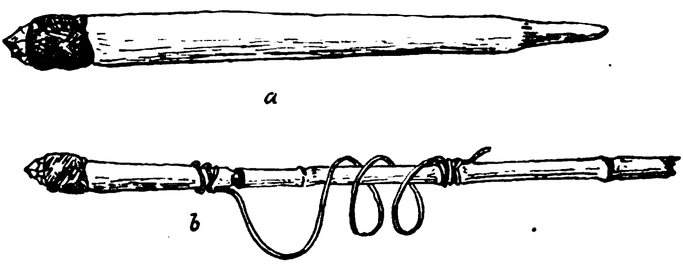


FIG. 16.—*a*, Tasmanian knife-pointed digging-stick; *b*, mounted in reed shaft as spear.

companion—pencil and wit-sharpener of those who write—long before man was weaned from the skirts of his Gray Old Nurse, the sea—born there, in time to drift with him, ere yet he left her side, over the whole shore-land world.

[1] The digging sticks of the Australian women (of the interior) were, unless tipped with stone, often six or seven feet long, and were used not only as implements, but also as weapons, either as quarter-staffs, sidewise; or as pikes or headless lances, endwise.

We have but to note the long and tapering forms of prehistoric stone knife-handles everywhere pointed—not quite usefully otherwise than as survivals of an early use—to believe in this thought as not improbable. Then, too, we may note the unearthed knives and harpoon heads of the early coast- and island-dwellers of California, or of the ancient fisher-folk of Peru and Chili (Fig. 17), to see that each is so like the other as to puzzle the sharpest observer. The handle of each, though preserving its ridges at either end, alike useful for grip-guard or reed-shoulder or tying (*b*), may not denote that each was used at so late a time indifferently for either purpose, but it seems to say that its ancestor was so used for very long. When, some time early, man found that the slim-handle

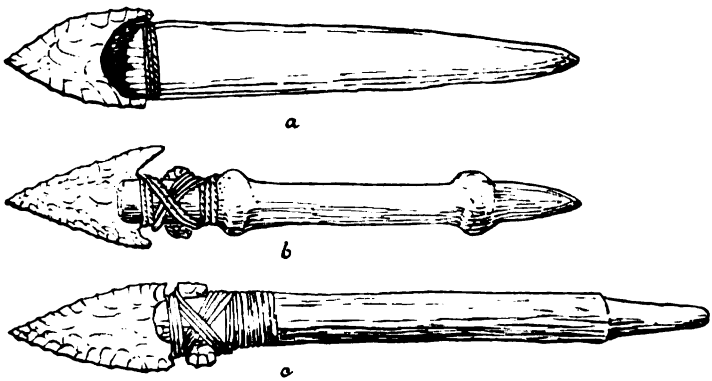


FIG. 17.—Knife-harpoon heads; *a*, California; *b*, Peru; *c*, Cliff-dweller.

knife, getting loose in the shaft of his spear, pulled out with the fish he had struck, but that if tied with a long enough string held its prey quite as well as the whole spear when held by a string in his hand, he had but to transfer his retrieving line, which always had hindered the fling, from hand-hold to mid of the shaft, and thence to the hilt of the head, to have formed a perfect harpoon (Fig. 18).

Imagine how men in those old days thought of the sharp-beaked shafts they cast at fishes and water fowl! They must have longed every day to emulate the osprey and the fish-hawk! But although they made their harpoons hook-beaked with barbs (or had made them so already) and claw-headed with recurved bone prongs, yet their flights of them were none the better for all that! Then why

not tie hawk feather or eagle plume to the body of the missile? How such feathers flew and flew, whether with the bird to which they belonged, or when dropped in the wind! Forthwith, you may be sure, they tied wing feathers to their shafts, two at first, midway; but lower down after awhile, and with a third feather, the "tail," for the smaller shafts, to keep them straight and headwise.

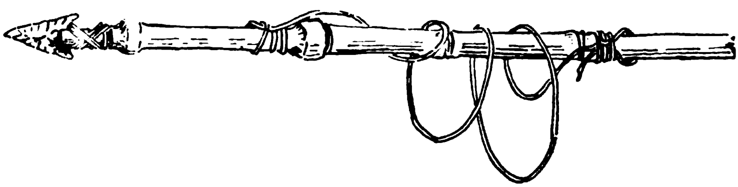


FIG. 18.—Knife-headed harpoon.

Primitive man never, until after the time of Homer, got over this believing (as his kind believe to-day), that the flying quality of the feather and of the bird from which it came gave light swiftness and sharp sureness to his bird-bolts, not the feathering in itself.

IX.

ORIGIN OF THE DART-FLINGER AND BOW.

Using spears and harpoons with irregular poles, or shafts of jointed cane, man found a mighty advantage in those which had knobs or joints large enough to afford sure grasp to the hand in throwing, especially men of the waterside, where their things were so often wet and slippery; and still greater advantage they gained from this experience later when, with plaited girdles or bands of other sort, they enlarged these joints at the grasping point or bound to the shafts, knobs or catches, or ever better and better device for the special work in hand (Fig. 19). They found, too, that for far throwing and small

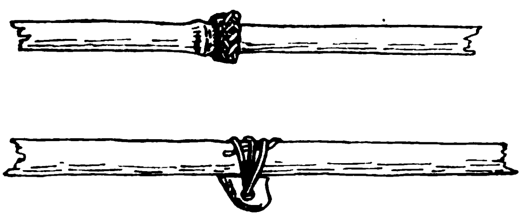


FIG. 19.—Shaft-girdle and clutching-knob.

quarry the light javelin was best, and that he who had the longest arm could hurl it the farthest; he who had the strongest fingers and could launch his missiles with one or another of them used as

a lever behind, like a hook against or inside of its hollow butt (Fig. 20), was surest of aim and sharpest of stroke.

So presently they began to fit the shafts with straps or their fin-

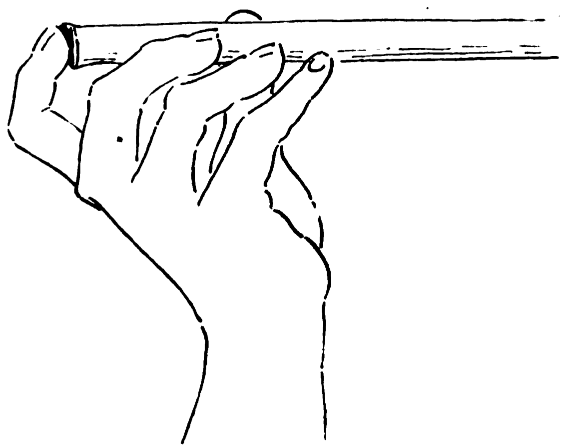


FIG. 20.—Finger-throw.

gers with slinging-nooses (Fig. 21) to farther the flight. From the soreness which came of much or constant use of such first appliancés (I have tried them and know), it was needful to make them ever better and better until the loops became rings for the fingers,

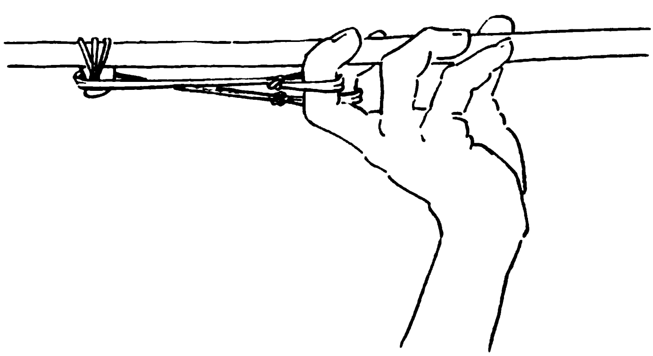
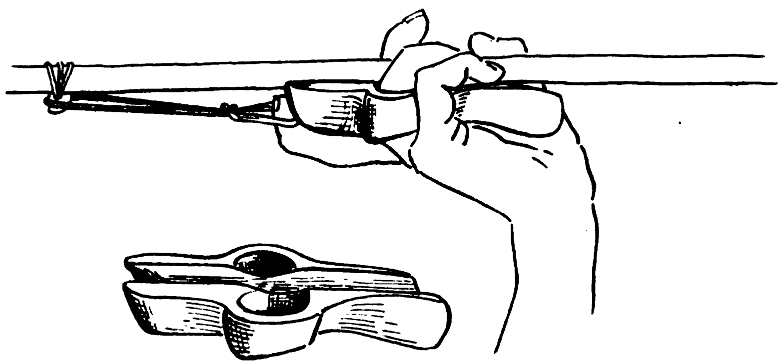


FIG. 21.—Spear-noose or slinging strap throw.

more rigid, and joined together; and these, in turn, became palms of rawhide for the throwing-hands, or of wood hollowed straight and fitted with holes at the sides for the thumb and great finger, and with a groove underneath, extending to the rear end, at which

was a notch or a hole for this finger when stretched back along the groove and thrust up through the hole or over the notch to hold the noose of the string-strap (Fig. 22) or press against the shaft-butt so as to project with force the spear when, if long, it was thrown with both hands.

Of such early devices as these spear-palms or graspers, so to call them, I have happily been able to find two historical examples, and doubt not others will yet be found. One of these, although a true spear-thrower, is quite such a palm as I have described, save only that it is a little too long and is furnished with a rude catch of bone in place, as it were, of the fore-finger-nail. It was rescued from the Santa Barbara Indians, ere they became extinct, by that great



FIGS. 22, 23.—Spear-palm and slinging strap.

voyager Vancouver.[1] There was found, too, some years ago, another of these things, even more archaic, a veritable spear-palm, such as I have described, but beautifully inlaid with bits of haliotis shell. I saw it in a collection of remains from the islands of the same region, but did not know, and no one at the time knew, what it was. I have now, however, identified it and reproduced a plain one like it (Fig. 23) and used it successfully. Perhaps the most interesting historic relics showing survival, I believe, of such uses of the spear-palm device as are here referred to are to be found in collections of Etruscan and early Roman remains.

[1] This specimen has been described in the Journal of the Anthropological Institute of Great Britain, vol. XXI, London, 1891, by Mr. Charles H. Reed, of the British Museum; and both redescribed and figured by Professor Mason in his little paper on "Throwing-sticks from Mexico and California," published in the proceedings of the National Museum, vol. XVI, No. 932.

At the Washington meeting of this Association, as may be remembered by some, my friend, that brilliant and many-sided naturalist, Professor Edward S. Morse (who did more for the study of "arrows" as a subject than any one previously, in his striking and oft-quoted work on "Arrow Release") held up before our section and discussed some of these remarkable little bronze relics, telling us that they were called "bow-stretchers" or "bow-stringers," ordinarily, in European museums; that, however, antiquarians were not satisfied, nor was he, that they were such, and that all sorts of opinions, equally inconclusive, had been advanced as to their possible use. He then, seeing me, handed the specimen to me, remarking very kindly that "if any one could make out their

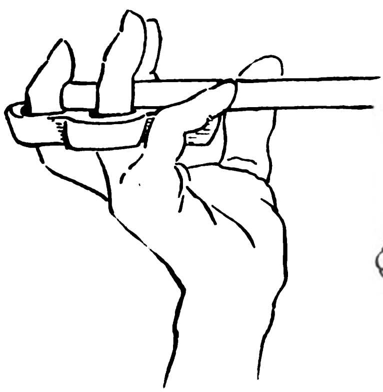


FIG. 24.—Finger position in spear-palm clutch.

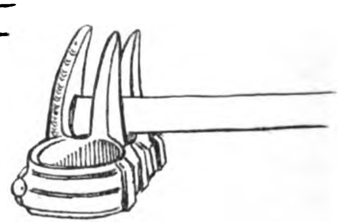


FIG. 25.—Etruscan "bow-stretcher;" probably spear-clutch.

meaning, Cushing could." Although then I was dubious, to-day I am grateful for both the compliment and the opportunity; for, comparing this old Etruscan relic with such a double spear-ring or clutch or such a spear-palm as I have described (Figs. 24, 25), one sees that the spikes or prongs on it so resemble the fingers when thrust up through the holes of a spear-palm like the Santa Barbara restoration, that they seem to have been made to replace them, as if to receive a spike at the butt of the spear, and thus enable the warrior to reserve the strength of his whole grasping hand for gripping and bracing the spear in close work or in projecting it far and with force when he would hurl it at the breast of the foe (Fig. 26). With this in mind, one sees, too, on re-examining the specimen, how the rings fit the fingers exactly for such use, and how they, and

the prongs also, show wear only inside, where they should be worn if used as I have supposed. Finally, in the ornaments of the particular specimens I have examined, one can see plain survival of the double-bent bands, the knotted fastenings of rawhide, and the prongs, of horn or bone, with which like spear-clutchers might have been made long before the age of bronze.[1]

Yet these early kinds of spear-palms and clutchers, while giving secure grasp and great power in the holding or hurling of heavy weapons, did not greatly increase the distance of their flight. So long as they only were known, there still remained the superiority of the long-armed thrower. But let us suppose that a man holding

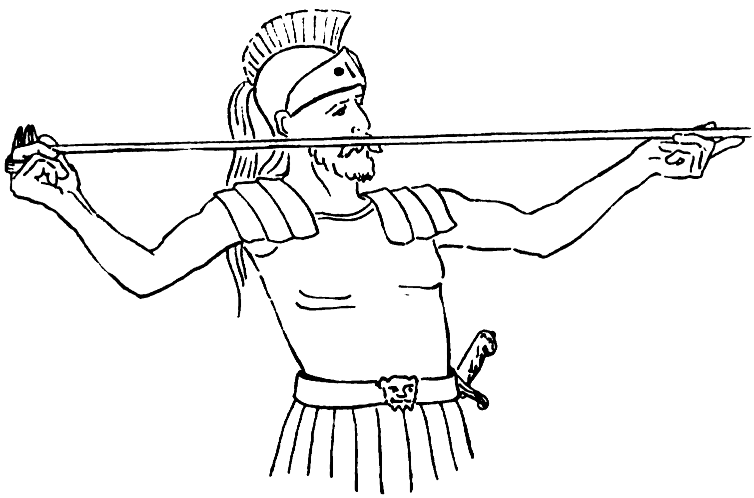


FIG. 26.—Spear-clutch throw.

an extra spear in the hand (point backward) with which he hurled another, happened now and then to catch the butt of the one thrown on the barb of the one held (Fig. 27), he would not fail to find that this gave great additional force to his cast. I conceive that it was

[1] Discussing this and my succeeding paper at the recent meeting of the American Association for the Advancement of Science, in Springfield, Professor Morse questioned the soundness of my theory regarding the primal use of these so-called "bow-stringers" or "stretchers." Referring to the great number of such relics which he had examined and sketched, he called attention to the fact that on some of them the prongs were replaced by mere knobs or protuberances. He further argued that such use as I assigned for them, although so important, was nowhere mentioned in classical writings.

In reply, I stated that even this later or bronze form of the objects in question was in the two specimens I had examined so perfectly adapted to the fingers for use

thus, or in some like simple way, that it was found expedient to lengthen out, backwardly, the rear- or finger-end of the spear-palm, if the spear-palm had come into vogue before that, and if not, to make an imitation throwing-spear, so to call it—a mere spindle or flattened shaft with a barb or hook at the end of it, like, for ex-

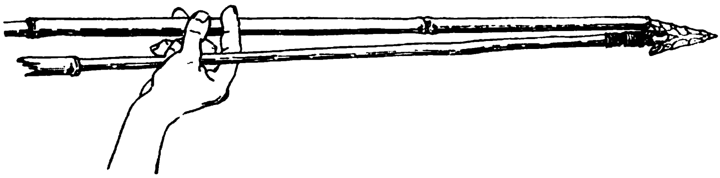


FIG. 27.—Throwing with spear.

ample, the throwing-sticks of the Australians (Fig. 28). The spear-throwers of the Eskimo (Fig. 29), so instructively classified and described by Professor Mason in his paper on "Throwing-sticks in the National Museum" (Report of the Smithsonian Institute, 1883), are regarded as the most highly developed forms of that

FIG. 28.—Throwing with throw-spear.

apparatus in the world. They certainly are the most elaborate: beautifully shaped to fit exactly the grasp of the throwing hand, and are provided with effective shaft-grooves and butt spurs or

in powerfully clutching and casting, say, a spear, that I was inclined still to believe even the knobbed examples he graphically sketched for us could well have served such purpose, or may at least have outlived such use originally in somewhat analogous uses. I would add also that while classical writers do not, indeed, expressly mention, so far as I know, the use of these bronze articles at all, nevertheless some of them, notably Xenophon in his Anabasis, do incidentally refer to straps and other devices for flinging spears, in connection with which these pronged and knobbed rings would have served admirably.

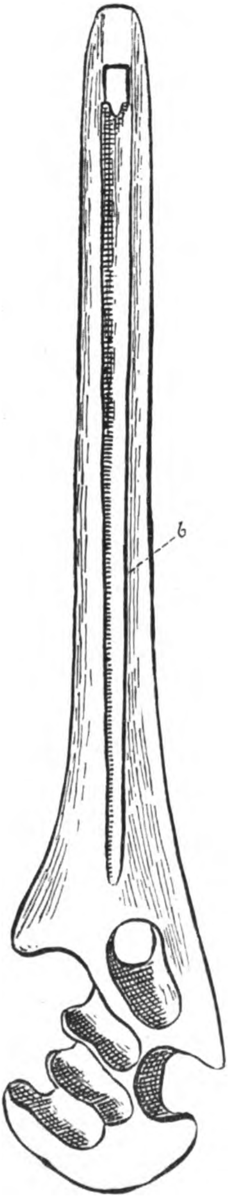
Be all this as it may, the general argument of the paper is not materially affected by this single illustration in it. I acknowledge that the small number of specimens I have studied, though typical, hardly afford basis for more than a suggestion as to their use or derivation, and I am grateful to Professor Morse, therefore, for his words of caution.

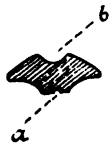
catches of ivory or bone. But there are some peculiarities of these throwing-sticks which relate them apparently to an undeveloped form,—quite directly to spear-palms somewhat like those of Santa Barbara and their greatly lengthened out descendant, such as is figured and described by Professor Mason (*op. cit.*) as having been found in use and collected near Lake Patzcuaro, Mexico, by our well-known, scholarly, and indefatigable writer on anthropology, my friend, Captain John G. Bourke, of the United States Army.

On examining any typical collection of Northwest coast throwing-sticks, or the illustrations of Professor Mason's paper relative to those of the National Museum, one will be surprised to note how many are marked or grooved down the backs or under sides (Fig. 30). The grooves, thus placed, have no apparent use; were put there, evidently, for some traditional or notional reason. In other words they would seem to be survivals, for some mere scratches, and all lead either directly from the finger holes or pits (or else from the side on which these or their substitute clasping notches or pegs occur) to the spur insertion or to beyond, being always painstakingly cut or scratched into or across the base of this hard ivory spur-block.

It is this groove particularly which appears to relate these sticks to one of the earliest forms, the palm-and-finger form (like Fig. 23), for they seem to be survivals of the finger-groove, lengthened out, perhaps, to accommodate the string, which was held noosed to the backwardly bent middle or fore finger and extended to the end of the stick, there to hold the butt of the spear or catch thereof until a bone finger (artificial finger-nail, as it were) was inserted, after which, as was fit in savage use, the groove was kept as a channel from the finger end to this extra end or nail, as a "way trail," so to say, through which the strength of the forefinger might reach the spear-butt or catch. I would like to refer to some examples of this groove as having probably been transferred in turn even from the throwing-stick to later forms, when these displaced its supremacy in use, as may be seen on certain bow-arms of the northwest region, the bellies of which are quite as uselessly grooved from grip, to horn or nock.

The element next higher in the development of the dart-flinger is not present, however, to any great extent, in the Eskimo forms, but it is to be found very decidedly exemplified in the throwing-slat or atlatl, quite independently identified by Professor Mason and





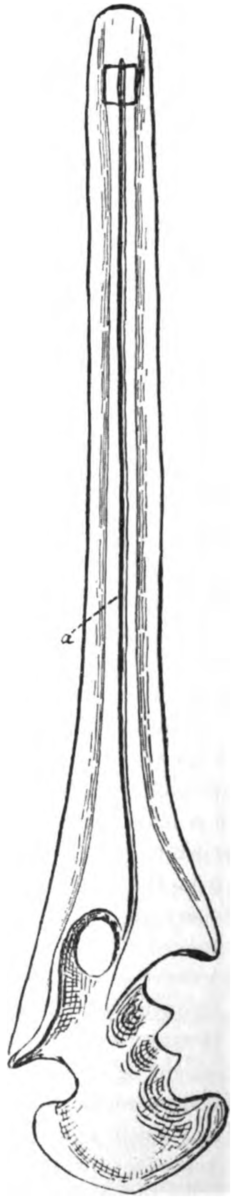


FIG. 29.—Front of Eskimo spear-thrower, showing shaft-groove *b*, and spur (see also section).

FIG. 30.—Reverse of Eskimo spear-thrower, showing back groove (*a* in figure and section).

myself in the remarkable Cliff-dweller collection I have before referred to.

Through the courtesy of my friend Mr. Stewart Culin, Director of the Archaeological Department of the University of Pennsylvania, I have been enabled to study out experimentally the original form of this interesting flinging-slat or -stick, and to reproduce it in its original condition, accurately and in working form. This little apparatus (Fig. 31) is made from a very slender and flexible sapling, of light and springy but hard wood, such as the Cliff-dweller bows were made of, the half or one arm of the more finished sort of which it almost exactly resembles—that is, the small handle is straight or slightly upturned from the ingeniously attached, spectacle-like finger loops or rings of hide, and thence toward the spur end it curves first downward, then rather sharply upward to the groove, which is short and shallow, and to the terminal spur-sink, which is only an inch or two long and is relatively deep. Thence to the end, a couple of inches more, the stick is curved down again so as to throw up the spur or catch and the little groove at the end of which it is cut; and thus the whole in profile and upside down resembles the arm of a Cupid's bow, save that the end or "horn" is thick.

Just above the handle and finger-loops is a heavy binding, first of sinew, then of yucca fiber, lastly of brown yarn, which at the outer end firmly seizes to the rounded (or under and back) side of the implement a fragment of beautiful black slag or limonite—the blood-clot of giants slain in Creation time with lightning of the gods of war, according to Zuñi lore. On the opposite or flat, upper, and front side, also at the outer

FIG. 31.—Restoration of Cliff-dweller throwing-stick or atlatl.

end of the bindings or packings, a beautifully ground and polished chalcedony knife-blade (the tip only of which protrudes) is bound on and probably served to divide the feathers, or as the "father of lightning" (to increase which it was doubtless ground at night), precisely as the lightning knives of the Zuñis are on their badges of war. Finally a little tusk of the wildcat is inserted into the packing on the same side, its protuberant point laid close against the finger loop, strap, or fastening, so as to hold it from slipping. I find that originally feather-work was whipped into the surface of the packing near either end—of red, yellow, and blue plumage, probably taken from the jay and the red-headed woodpecker of the south or from humming-birds. All this was both fetishistic

FIG. 32.—Cliff-dweller atlatl or throwing-stick in use.

(the life portion of the flinger) and to brace the knuckles so that the spear could be easily held high when flung. Thus the shaft of the dart did not lie along the upper face, as in other and long-grooved examples, but merely touched the counter-sink near the spur or catch at its end. As the result of this method of release and of the curved and flexible style of the flinging-stick, the spear or dart could be sped with a spring, which added so greatly to its force that, with my reproduction of the cliff specimen, I can throw the harpoon twice as far (Fig. 32) as with my Eskimo specimen, with less trajectory and hence more accurately.

Among a people armed with such effective flingers, I do not

wonder that their use survived that of the bow, even away from the appropriate habitat of the spear-thrower—the water side; nor need one wonder that the famous atlatl of the ancient Mexicans, made famous anew by the amazingly convincing and beautiful study of it Mrs. Zelia Nuttall has given us in the first volume of the Archæological and Ethnological Papers of the Peabody Museum (Harvard University, 1891), and which atlatl is, I believe, the lineal descendant of this one of the Cliff-dwellers, feather-work, fetishistic element, and all; nor that it should also have been even more highly valued for special purposes by the Aztecs than was the bow, for in its many southern forms, as figured by Mrs. Nuttall, are to be found still higher developments. I refer especially to the crozier-shaped ones and to those "with straps" (Fig. 33, *a*, *b*), recalling Fray Diego de Landa's most significant description of the Maya forms seen by him in the sixteenth century.

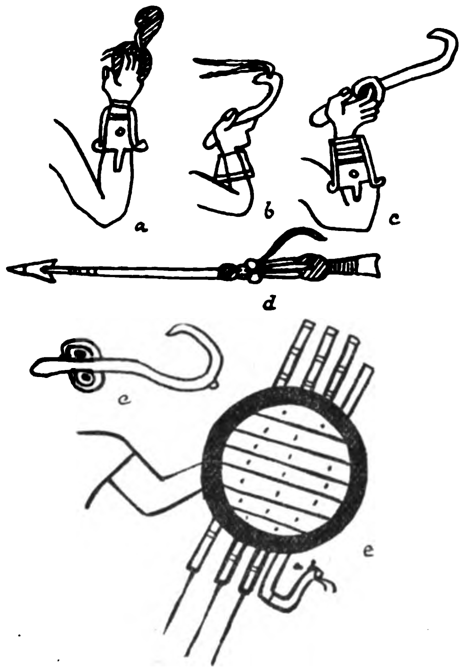


FIG. 33.—*a*, Maya representation of crozier-form atlatl held close, with strap, for throw; *b*, ditto, released, straps flying (Dresden Codex); *c*, *c*, Maya and Mexican crozier-shaped throwing-sticks; *d*, Maya spear with holding strap; *e*, ancient Peruvian sheaf of darts, shield, and symbolic throwing-crook (from Chimu vase painting).

Now, the crozier-shape or bent form of the spear-flinger (Fig. 33, *cc*, *e*) was, as my experiments have indicated, a veritable combination of the bow and the spear-thrower. In it the spring of the bow already appears. It is simply a stringless bow, used backward, while in the still more elaborated form of it, that of the Mayas, the string also appears, only it was loose at one end (Fig. 33, *a*, *b*) or else attached to the spear shaft itself (Fig. 33, *d*), as

shown by the plates in the Dresden Codex (which has opportunely been sent to me within the last two weeks by that generous patron of anthropologic research, M. le Duc Loubat). Were I uncertain of the meaning of these forms I might be reassured by certain evidences furnished by the Zuñi. The Zuñi still have traditional knowledge of the use of the spear-thrower and its appropriate hoop or net shield by their cliff-dwelling ancestry, and the truthfulness of their vague traditions is substantiated by certain survivals among them. One of these, as exemplified in certain spear and ring games, I shall refer to in the following part of this paper. The presently

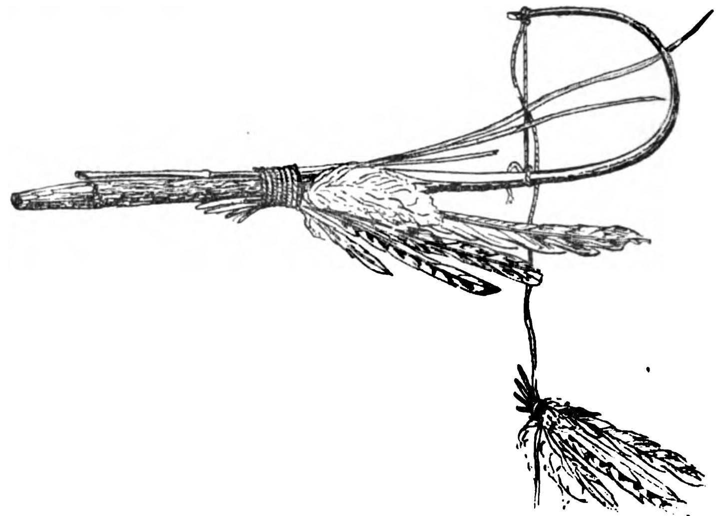


FIG. 34.—Zuñi plumed prayer-stick of war sacrifice, or "Bearer of the reed of war."

significant one is apparent in their little crooked or crozier-shaped prayer wands or staffs. Some of these are actual staffs in miniature, and symbolize the prayer journey and a number of other things; but the warrior and hunter symbol and sacrifice of this shape differs from these in being supplied with a holding string. It consists of a split twig about a foot long, the upper end of which is bent far over, like the head of a shepherd's crook (Fig. 34), and tied at right angles to the main part of the shaft with a taut string, on the middle of which is a double knot or a dab or two of black paint. It is plumed on the handle portion or near the base; and, attached to it inside, so as to lie along it and against the

string at the "knot" or paint dab, is a sprout or stem of cane or reed-grass. If this little "carrier of the cane" or "war-staff" be but enlarged or restored (as I have experimentally restored it) and used with a notched spear-dart like those of the Dresden Codex, with or without straps, and if then the missile be pressed back against the string and held with fingers (or by its strap) until released with a fling, the rebound of the string, as well as the spring of the flinging-staff, adds treble velocity to it. And it seems to me that the steps are few and short from this already strung but reversed flinging-bow (Fig. 35) to the bow of archery.

That such steps were actually taken, not in one land and by one people alone, but in many lands and by many peoples (and from differing forms and styles of throwers to differing developments of the bow), can, I think, already be shown. In the first place, the

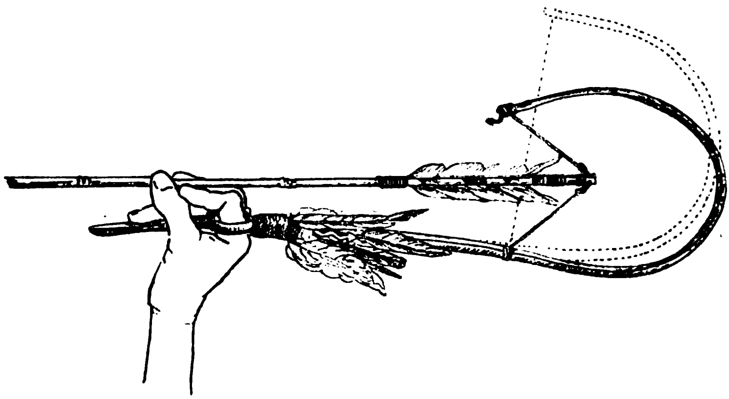


FIG. 35.—Restoration of ancient stringed spear-crook or throwing-bow (from Zuñi prayer-stick of war).

Zuñi name for the bow is significant. It is *pi'-'hlan-ne*, from *pi'*, "a string" or "stringed" (emphatic form); *'hlam*, "a slat," "stave," or "staff," and *a'-ne*, "to go," or *a'n-a-ne*, "go-thing"—that is, "a stringed go-staff" or "stringed *go*-slat." "To shoot" (with an arrow) or "to hunt" is *'hala'-ta*—that is, "slat-direct" or "staff-aim"—whereas the name for an arrow is *sho'-o-le* ("cane" or "reed"), and is not, it will be seen, referred to in this etymology. Again, to hit or pierce with an arrow is *'hlat-k'u* from *'hla'm*, "a staff" or "slat," and *t'e-k'u*, "to stick into"—that is, "to slat-stick" or "slat pierce," in the sense of piercing or sticking into, from or by means of, not with the slat. Now, all these terms, especially the latter two, were formulated, I take it, from use of

the throwing- or flinging-staff, not from use of the bow in its later form; and they would indicate that, with the Zuñi ancestry at least, the throwing-stick both antedated and gave rise to their later present form of bow. Of this there is far more additional evidence than I can offer here. Nor can I enter into the intensely interesting results of my experiment study of Mexican and Mayan forms of the throwing-stick, all indicating even more strongly the same thing, and indicating also the directness of derivation from our own great southwest, of art elements, at least, in these old cultures of the

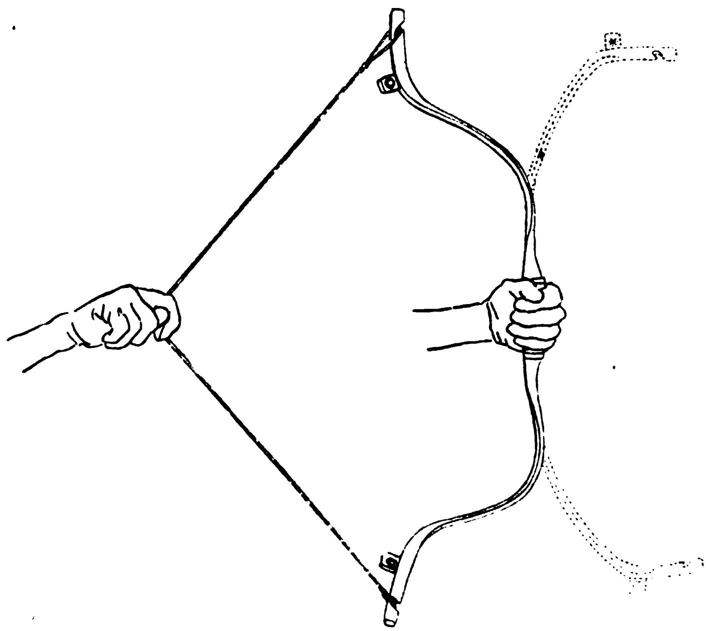


FIG. 36.—The "Tartar bow," as drawn, released, and reversed when braced with slack string.

south. I must, on the contrary, turn a few moments to other lands.

In old-world countries, language tells much the same story in, for example, Chinese and Korean terms and characters, according to Mr. Culin's profound studies of these people and their languages, and in the Arabic,—of which that brilliant and universal scholar, Dr. Talcott Williams, tells me archery terms are apparently quite as dissociated in derivation from an original use of the bow with the arrow as are those I have above analyzed.

When talking on this subject with my lamented friend, the

artist, Thomas Hovenden, who went to his noble and heroic death but a few days ago, he did not at first understand and quite believe in my theory, but pushed a canvas toward me, and handing me a charcoal stick, bade me draw the form of thrower I then thought was the connecting link between flinger and bow. I drew one—a long, slender twig, with a fork at the end, and a string attached to the crotch, both for catching the spear and for bending the stick to give it spring when loosed. He looked astounded for a moment, then delighted. "Do you know," said he, "that as a boy I played with such a sling-stick as that, as other boys commonly did when bird hunting on the Irish marshes—" and in the morning he made me one. It was my hypothetical connecting link between spear-flinger and bow.

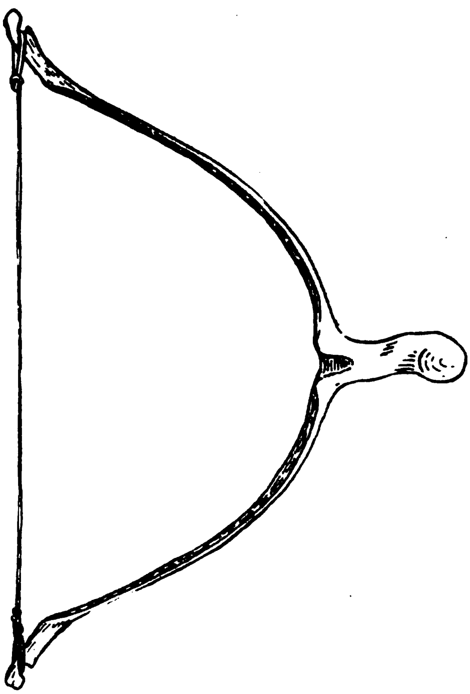


FIG. 37.—Primitive crotch-bow, wide antlers.

Dr. Williams also informs me that when he was a boy the young Indians of central New York used some such apparatus, half toy, half weapon, and that his father once made one for him. You are all familiar with the dart-springing stick, which is stuck in the ground and while held by one hand is pulled back by the other to fling the dart. Certainly every one is acquainted with the "slap-jack," destroyer of so many window-panes in school-rooms and on city streets. You approvingly remember also, I hope, what I have said on an earlier page, of toys; but I wish to explain for a moment the development of a throwing-crotch resembling these things, in a part of the world where its study serves to explain more than merely the origin of its appropriate

form of the bow. I refer to the vast area of the so-called "Scythian" or "Tartar bow." Any one who examines one of these extraordinary bows, and especially who notes the manner of its use, will not find much difficulty, it seems to me, in tracing it back to what appears to have been its ancestral form in a simple forked twig or flinging-crotch, the steps are so obvious and few.

The Tartar bow (Fig. 36) is a built-up bow, excessively flexed, not toward the belly, as are bows usually, but toward the back, its ends or horns being still more backwardly flexed. so that they even approach each other when the bow is slacked. The string-nocks are deep and slanting, and at the base of each horn or ear

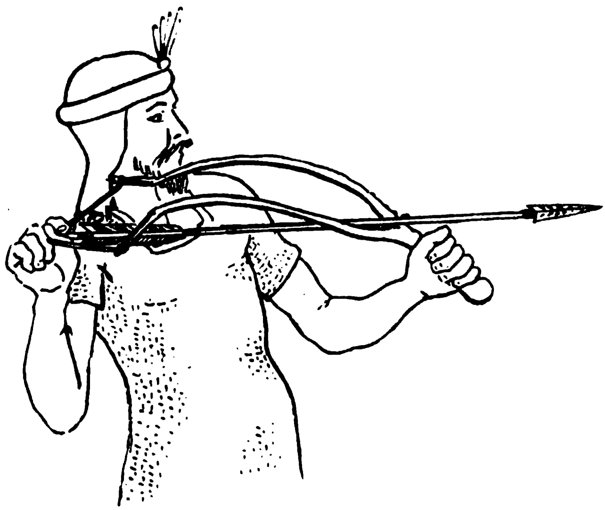


FIG. 38.—Mode of bracing and releasing bow-crotch.

is attached, on the belly side, a bone or other hard block, chiefly to catch or slip the string when rebounding, but pierced transversely in some specimens. Through these blocks the ends of the string used sometimes to be passed from one side before being noosed to the nocks, or else it was knotted one-sidedly to the nock of the upper arm. Thus when the bow was drawn, not only were the arms reflexed more than twice as far by a pull of but the same distance to the rear of the grip or bow-hand than they would be on the ordinary bow, but the string pulled more to one side than the other, so that the curious overhand release some-

times observed among Tartar, and, I am told, some other Mongolian tribes, was not only facilitated, but in these cases was rendered inevitable. Thus an arrow was half shot, half flung, or cast from such a bow, and it is this which makes the thumb-ring pull and the overhand release natural and which challenges our attention; for the motion of the release (Fig. 36), no less than the form of the bow, seem both to have been directly derived from a

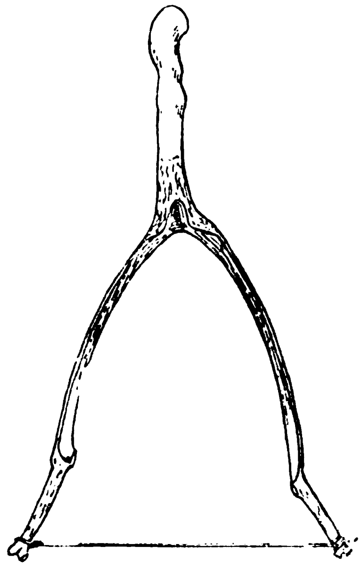


FIG. 39.—Primitive bow-crotch, narrow antlers.

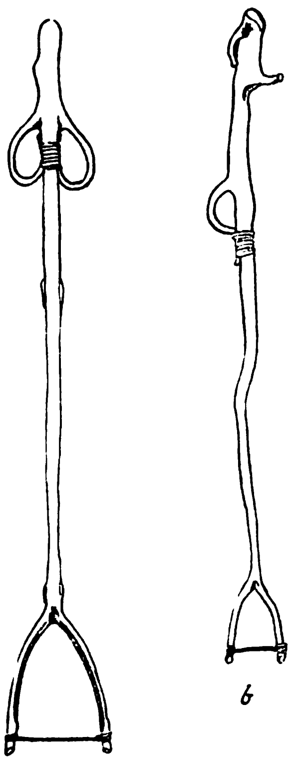


FIG. 40.—Dart-flinger crotches; *a*, developed form; *b*, early form.

wide-antlered, two-hand dart-flinging crotch (Fig. 37)—half slinger, half bow—which probably suggested a still wider-armed, spliced and haftless crotch or bow, and thus almost immediately preceded it in development. With such a crotch, if stringed between the two antlers or branches and grasped in the left hand by the handle at their base or juncture, while with the thumb of the right hand the string was drawn back—the dart meantime being held thereto with the fingers of the same hand and thus braced for release (Fig. 38)—one can see that with a sharp fling the dart would be discharged over the crotch and the string fly over the bow-hand, much as it does in the Tartar bow-release, so to call it. This form in turn is but an improvement on

the one less spread and depending on both outward and forward release-spring in its antlers (Fig. 39); and this, finally, is but little better than one in which the spring of its still less separated branches was forward alone, and was its sole advantage over the long-branched and flexible but one-handed throwing-crotch (Fig. 40, *a*), recalling in some ways the unrelated Celtic form my friend Hovenden made, and the primal short-branched sling-crotch (Fig. 40, *b*) in which it would seem was the germ of this peculiar sort of built-up and compound ancestor of the Mongolian bow.

[NOTE.—The second part of this address, referred to on page 234, was delivered before the Section; but Mr. Cushing, who is exploring in Florida, has not been able to prepare his copy although the volume has been held for a long time with the hope of receiving it. The paper will probably be printed in the Journal of the Anthropological Society.—EDITOR, March 2, 1896.]

PAPERS READ.

The Cosmogonic Gods of the Iroquois. By J. N. B. Hewitt, Bureau of Ethnology, Washington, D. C.

With the exception of that of the learned Lafitau in the early part of the eighteenth century and that of Dr. Daniel G. Brinton in the middle of our century, no serious attempts have been made to define and interpret the subjective creations—the cosmogonic gods—of Iroquoian philosophy.

The former attempted little more than a characterization of the chief cosmogonic gods of this cult, while the latter endeavored to show what phenomena in nature these gods impersonated, but his essay is vitiated by an unsuccessful attempt to make the facts in the case support an erroneous preconceived theory.

In the protology of this people, we see in full operation the effect of the imputative method of explaining the phenomena of nature, in the endowment with subjective attributes of the bodies and powers in nature. Herein lies the key to the entire cosmology of the Iroquoian people.

If the evidence of language may be trusted, it seems safe to regard these gods as creations indigenous to the primitive philosophy of the Iroquois regarding the origin of themselves and their environment—the protology of their existence and that of the earth and the heavens.

The character and functions of the various bodies and forces in nature determined the rank they hold in this cosmology.

A brief outline of the cosmology of the Iroquois may aid in understanding the analyses of the names of the cosmogonic gods of this cult.

The Iroquoian account, as told by the Oṅondaga shamans, relates that before the formation of this earth there existed in the sky a world similar in every respect to this and inhabited by people endowed with faculties similar to their own. That sky-world had no need of the light of the sun or of the moon. Fast by the lodge of the chief of the sky-people stood a huge celandine-tree and its golden yellow blossoms lighted the firmament of the sky-world. The sun and the moon are peculiar to this world. The chief of the sky people is called by the Iroquois in general *Tha·ro*^{n}*-hya-wă''-ko*^{n} and by the Onondagas by this and in particular by the name *Ha-oñ-hwĕñ-tcya·wă''-ko*^{n}. In the course of time *Tha-ro*^{n}*-hya-wă''-ko*^{n} received an offer of marriage from the daughter of the first of the sky-people to

taste death. Both the father and mother of this girl were born with cauls and so both were "hidden" until the age of puberty.

Tha-roⁿ-hya wă'ʹ-koⁿ after subjecting her to a severe probation accepted the girl in marriage, and to solemnize the espousals he caused corn to fall like rain into the houses of her patrial people so abundantly as to fill them. Then after a visit to her people his wife returned to him, but noticing that she was "cinctured" (énciénté), *Tha-roⁿ-hya-wă'ʹ-koⁿ* became so enraged by jealousy that he became ill and lay unconscious for days, until he ordered the pulling up of the light-giving celandine-tree by the roots, and cast his new spouse into the hole through the sky made by the uprooting of the tree. This cured the sky-god of his jealousy. This woman whom the Hurons called *Eatahĕⁿ 'tsik* [Aataentsik] fell into our firmament; whereupon the water fowl and amphibious animals constructed the present earth for her abode. Five days after her fall she gave birth to a daughter, who in five days attained full growth. The daughter, whose name seems to have been entirely forgotten at an early period, espoused a turtle in the assumed form and lineaments of a handsome young man. When he came to lodge with her, he placed over her bed two arrows, one having no head and the other headed with flint. Before day he left his spouse's side. From this union the daughter of *E-yă'-ta-hĕⁿ-tsik* was brought to bed with twins. Just before they were born the young mother heard the one say to his mate, "It is now time to be born; I will go the natural way," to which the other replied, "I will go out this way; it is thin here, for it is transparent," at the same time tapping his mother on the armpit. The first was born in the natural way, while the other burst through the armpit of his mother causing her death. The grandmother of the twins, *E-yă'-ta-hĕⁿ-tsik*, asked "who killed your mother?" Whereupon *Tawĭskară'*, the real culprit, exclaimed, "He did it," pointing to his brother, called *Otĕñ-toñ nĭ'-ă'*, whom the grandmother seizing threw over the lodge into a clump of shrubbery; but being supernatural he did not die, to the great chagrin of the grandmother. Then, *E-yă'-ta-hĕⁿ'-tsik* cut off the head of her dead daughter and affixed it to the top of a tall tree where it became the sun, and in like manner affixed the body which became the moon, and it is said even now that we may discern the outlines of the folded legs and arms on the face of the moon. At a later period these two luminaries were placed in the sky. Up to this time it will be seen the earth had been lighted by cosmic light alone, which in Tuskarora is called *u-kyĕ-hĕⁿ'-stĕ*.

E-yă'-ta-hĕⁿ-tsik made *Ta-wĭs'-ka-ră'* her especial darling, and in all after time she and he worked together doing those things that gave trouble and pain to man. On the other hand the sole aim and desire of *O-tĕñ-toñ-nĭ'-ă'* found expression in his constantly doing everything to promote the welfare and comfort of man immediately and prospectively.

This is but the baldest outline of the main features of the cosmology of the Iroquoian people as related by the Onondaga shamans of to-day. The other extant versions differ from it only in details.

With this preliminary sketch of the cosmogony of the Iroquois,

attention may now be given to an attempt to analyze the names and to interpret and identify the phenomena in nature represented by these subjective creations of barbaric philosophy.

Tha-roⁿ-hya-wä'ʹ-koⁿ or *Ha-oñ-hwěñ-tcya-wä'ʹ-koⁿ*.

Tha-roⁿ-hya-wä'ʹ-koⁿ was the ruler of the sky, which modern research has shown to be an optical illusion only. Being one of the apparently largest bodies in nature and one that is ever present whether by night or day from all time, and one that is unaffected by the lapse of generations and the rough turmoil of storm and tempest, it naturally came to be regarded as the oldest of powers—the Ancient of Days. The serene, immobile passivity of the sky, its preponderating greatness and grandeur, thus moved the Iroquoian thinkers to clothe its embodiment with supreme power and strength, representing him as existent "without father, without mother, without descent (*i. e.*, pedigree), having neither beginning of days, nor end of life," as ever benign and beneficent, at all times solicitous to promote the welfare of man, and in great emergencies even descending among men personally to aid them against adverse powers and beings of sinister aspect and malevolent purpose. From the brief introductory account of the protology of the Iroquois, it would seem to be erroneous to identify *Tha-roⁿ-hya-wä'-koⁿ* with *Yoskehä'* of the Huronian version or with *Otěñ-toñ-ni'-ä'* of that of the Onondagas and other tribes, for the latter is the demiurge, being, strictly speaking, the grandson of the spouse of *Tha-roⁿ-hya-wä'-koⁿ*, *E-yä'-ta hěⁿ-tsik*.

Since the sky appears to be sustained by something, to be, in other words, held up, it was argued that its master held it up; hence, the name of this master, *Tha-roⁿ-hya-wä'-koⁿ* which signifies "He holds fast the sky." The elements of this name are the following,—the initial *t*, the ancient and now obsolescent sign of duality, formerly used to denote the action of *two* things that were double by nature, as the eyes, hands, feet etc., but in modern Iroquoian speech it has become expletive rather than aught else, since it is in many cases impossible to give it any significative value in the expression with which it is connected; *ha* is the singular masculine, third person of the pronoun of the anthropic gender, meaning "he;" *-roⁿ-hya* is the noun *o-roⁿ-hyä'* without its unmodified gender-sign, meaning "the sky, the visible heavens," and in some dialects "blue," also, it being a derivative from the verb *-u-rŭk*, "to cover, spread over;" and, lastly, *wä'-koⁿ* is the perfect tense of the obsolete verb *wä' k*, "to seize, enclose, embrace, hold fast," as with the hands, claws, etc.; although a past tense it has a present meaning.

The Onondagas and, perhaps, other tribes of this family apply to this god another descriptive name, *Ha-o-hwěñ-tcya-wä'-koⁿ* which means, "He holds fast the earth." This name differs from the former in only two respects, namely, the lack of the initial *t*, and the substitution of the noun *o-hwěñ-tcyä'*, "earth, the world," instead of *o-roⁿʹ-hyä'* of the former expression. The lack of the initial *t* in this name shows the correctness of the remark made above that it is obsolescent, for the verb used in both

instances is one and the same and so is the subject. The latter name embodies the belief that the sky holds up the earth for which purpose it touches the earth along the horizon. Thus, the attitude or situation of the sky fully and clearly explain both names, indicating how the Iroquoian people sought to name the prime mover of the sky. In a Tuskarora legend, the sky-god is represented as arrayed in a mantle of blue-colored dog-skins. This is probably one of the considerations why the Onondagas and other tribes of this family sacrifice a dog to this god at a solemn feast in the month of (?) February.

E-yă'-ta-hĕⁿ'-tsik.

As the whilom spouse of the sky-god, it seems fitting to take up for discussion next the goddess whom the Hurons called *Aataentsic*, but which the present writer spells *E-yă'-ta-hĕⁿ'-tsik*, as it seems to represent better the sounds sought to be recorded by the first orthography in this paragraph. This goddess while dwelling in the sky-world became the spouse of the god of the heavens, *Tha-roⁿ-hya-wă''-koⁿ*, but for some indiscretion which aroused the implacable jealousy of her spouse, she was cast down into our atmosphere; for her lord in his frenzy of jealousy ordered his friends to uproot the light-giving celandine tree, which being done made a hole so long and deep that it extended into our firmament; and it is claimed that the sun now shines through the aforesaid opening.

E-yă'-ta-hĕⁿ'-tsik is represented as malevolent towards mankind, spoiling or destroying as far as lay in her power whatever of good *Yoskehă'* had done for the welfare of the race, as presiding at the death-scenes of men, she herself sucking out their life-blood, causing them to die by disease and exhaustion, and as feeding upon serpents, vipers and other reptiles.

As the queen of the manes she received as tribute all that which was placed in the grave, compelling the unbodied spirits to dance for her health and amusement.

There is some difficulty encountered in attempting an analysis of the name *Eyă'tahĕⁿtsik* [*Aatahensic*, etc., are other forms, but the one in the text I adopt as representing what I regard as the best]. Lafitau says, "c' est un nom composé d' *Ata*, qui désigne la personne, et de *entsi*, qui, dans la composition, signifie un excés de longueur, ou d'éloignement de temps et de lieu, ou qui est un superlatif en matière de bien ou de mal" [244 p., T. I.]. The first objection against this derivation is that *ata* in none of the dialects designates person; *entsi* is not a form of the adjective *es*, "long [to be]," and withal no account is taken of the final *c*- or *k*-sound; and, second, this is not a form of the intensive enclitic *tci*, "very, fully," as might be supposed. These are all fatal to the accuracy of the derivation. Another etymology of the expression has been proposed by Dr. Brinton, but had the learned Doctor known the fixed rules governing word-position in Iroquoian composition he would never have given it a second thought. He attempted in this analysis the fulfilment of a preconceived notion of connecting this name with another Iroquoian descriptive term, *Aouen*, meaning "water," compounding it with the verb-stem *at*, "to be in, to be

contained." There are two fatal objections to this derivation. In the first place, *Aouen*, *A'wěⁿ'* for **wa'-ěⁿ'*, being a sentence, cannot enter into composition with individual or other words, and second, the morphothesis or word-order of the verb is that it invariably follows the noun with which it is combined, while Dr. Brinton unwittingly makes it precede the element with which he attempts to combine it.

Brebeuf affirms that, to the Hurons, *Yoskehă'* denoted the sun and *Aataentsic*, the moon, asserting that she could assume whatsoever form and figure suited her. But here there was a confusion of characters. It was the daughter of *E-ya'tahěⁿ'tsik* who became the moon which changes its form continually. It is a very common thing among writers to confound *E-ya'-ta-hěⁿ-tsik* with her daughter, and hence arises the erroneous identification of *E·ya'-ta-hěⁿ'-tsik* with the moon. The very fact that there is a uniformity in designating her as the grandmother of *Yoskehă'* may be taken as evidence that it is an error to make her his mother in direct contradiction of the clear and uniform declaration of the cosmologic legends.

On both linguistic and functional grounds, I am inclined to regard *E-ya'-ta-hěⁿ'-tsik* as the impersonation or goddess of night and the earth. The analysis which I offer is strictly within the fixed rules of Iroquoian sentence formation and is not opposed to any phonetic objection. The orthography *Eataentsic* was used by Brebeuf, in 1635, but in the following year he adopted the spelling *Aataentsic*, and only once does he use the spelling *Ataentsic* which is the form of the expression usually found in the literature pertaining to the subject. But after due consideration, I believe that the spellings *Eataentsic* and *Aataentsic* are the nearest approximations to the expression as actually uttered now more than 250 years ago; the fact that both these orthographies have two vowel sounds at the initial part of the expression makes for the derivation which I am about to suggest. But, the fact that this name is not found at present except in the literature of the early Huron period must not be accepted as ground to conclude that the legend was the product of a distinctive Huronian cosmology, for the other terms in it, or, at least, some of their elements, are found in all the dispersed branches of this family of tongues. Hence, we may infer that this cosmology belongs to the proethnic period of the entire group of tongues, for even among the Tceroki the name *tawiskara'* is found designating "flint."

Adopting the first orthography of Brebeuf as representing approximately the true sound of the word-sentence, I will spell it as follows, *E·yă'-ta-hěⁿ'-tsik* or *E-ă'-ta-hěⁿ-tsik* which is substantially that of Brebeuf, and which I resolve as follows,—*E* is the indefinite, or specifically, feminine, anthropic pronoun of the singular, third person, meaning "her," and *-yă'-ta*, the noun *oyă' 'ta'* without the prefixive gender-sign o-, meaning "body, the body of a living being," *-hěⁿ-tsĭ*, the adjective, "black, swarthy, swart," and the enclitic *-k*, which is a contract form of the substantive verb *ĭ'kěñ* "(it) is;" the entire synthesis meaning literally "her body is black," or, freely, "she whose body is black." In this analysis, I repeat, no phonetic law or grammatic rule of the language has been violated.

Thus, I believe, we find ample linguistic evidence showing that *E-yă'-ta-hĕn'-tsĭk* is not the moon goddess but rather the goddess of "black night."

Moreover, one of the most dramatic episodes related in this cosmology is the theft of the sun by *E-ya'-ta-hĕn'-tsik* aided by *Ohă 'ä* or *Ta-wis-kară'* who carried it to the eastward into an island in a vast sea of water, for the purpose of depriving the earth and man of light. But *Otĕñtoñnĭ'-ă'*, in his capacity of demiurge, saying, "it is not good that men should dwell in darkness," and calling his trusted friends, Beaver, Fisher, Fox, Raven and Otter, brought, after great difficulty, the sun back to supply uninterrupted light to man,—that is, so that there would not be darkness and night but continuous day. But, by a blunder of Otter a compromise had to be made with *E-yă'-ta-hĕn'-tsĭk*, who stoutly insisted on the sun being returned absolutely to her, it being agreed that day and night should divide equally between them the empire of time. In this circumstance, there is allusion made to the seeming theft of the sun by Night every day when the sun sets.

Lastly, the usual application of the appellation, grandmother, to the moon must not be construed as evidence that the grandmother of *Otĕñtoñnĭ'ă'* is meant, for the mother of *Otĕñtoñnĭ'ă* being born on the earth was, in fact regarded as the grandmother of the race in a stricter sense than her mother, *E-yă'-tă-hĕn'-tsĭk*.

Yoskehă'—Tawiskara'.

Following the many erroneous hints given by the Jesuit priests in the *Relations des Jesuites*, Dr. Brinton does not hesitate to identify *Yoskehă'* with the sun even giving a fanciful analysis of the name in support of his theoretic identification. But, I believe that a careful study of the character of *Yoskehă'* will make it clear that *Yoskehă'* was not primitively the impersonation of the sun, but there may have been among the laity those who thus confounded him not only with the Sungod, but also with *Tha-ron-hya-wă''-kon*, the sky-god, and so there is no great ground to wonder at the confusion of characters.

In the protology of the Iroquois *Yoskehă'* or *Otĕñtoñnĭ'ă'* is the demiurge in contrast with *Tawiskara'* his brother, who represented the destructive or Typhonic power in nature as exemplified by the destructiveness of frost, hail and ice, often holding for months in its stiffening, solidifying, deadening embrace, the rivers, lakes, and ponds, the sap of the trees, plants and vegetation of the land. The people hold in high esteem the great and bounteous benefits they believed they enjoyed only through the care and benevolence of *Yoskehă'*. Success in hunting was assured by his aid, for they believed that the game animals were not always free, but were enclosed in a cavern where they had been concealed by *Tawis'kara'*. But, that they might increase and fill the forests, *Yoskehă'* gave them freedom but in a manner such as to enable him to control them at will for the welfare of man. To this desirable end, it is said, he wounded them all in the foot, with an arrow, the wolf alone escaping the stroke, whence it is so hard to take him in the chase. When, in the beginning of the earth's

existence, it became dry and sterile by reason of the absorption of all the waters under the armpit of a great frog and none could be obtained without its permission, it was *Yoskehä'* who resolved to free himself and all his posterity from this bondage. To do this he made an incision in the side of the frog, whence the waters issued in such abundance that they spread over the whole earth, thus forming rivers, lakes, seas and all the cooling water fountains. Having learned the invention of fire from the tortoise he taught men the art of fire-making, so that they could have, when needful, new fire. The corn they eat was given them by *Yoskehä'*; it is he who causes it to sprout, grow and come to maturity; if in springtime their fields of corn, beans and squashes are green; if they gather ripe and plenteous harvests, and if their lodges are filled with well matured ears of corn, their gratitude is given to *Yoskehä'* alone. In 1636, it was predicted in the Huron country that a great famine menaced the land, simply because *Yoskehă'* had been seen lean and emaciated like a skeleton, holding in his hand a blighted ear of corn and gnawing with his naked teeth the leg of a man, for these prodigies were the unmistakable omens of a very poor harvest. *Yoskehä'* labors, plants corn, drinks, eats and sleeps, and is lascivious like man. His lodge is made like their own, being well supplied with whatsoever sustains life. He is of a benevolent nature, giving increase to all, doing only that which is good, and vouchsafing fine weather. When he becomes aged, he can in an instant rejuvenate himself, making himself a young man of about twenty-five years, and so he never dies, although somewhat subject to bodily infirmities.

With this brief outline of his character, let us see what meaning may be obtained from an analysis of his names, *Yoskehä'*, *O-tĕñ-toñ-nĭ'-ä'*, or *Otĕñtoñnĭhä'*.

The latter is the name applied to him by the Onondagas and it signifies, according to the best native authority I could obtain, "the dear, young, or precious, little shoot or sprout." The final *ä* or *hä* is the adjective denoting "small," but here it is used as a caritive. Speaking a language cognate with that of the Huron, it is probable that the Onondaga name is a mere translation of the Huron name. An analysis of the latter confirms this view. In Mohawk and in Huron *O-skä'* signifies "a sprout or shoot," the initial *yo* or *io* is the neuter singular third person of the pronoun, meaning "it," and the final *-hä* is the adjective "small" having here also a caritive force explained above, the whole then signifying, "it is the dear little shoot or sprout." If these analyses be correct, and there seems to be no valid phonetic or grammatic objection, it is seen that *Yoskehä'* and *Otĕñtoñnĭ'ä'* are figurative expressions denotive of the growth-producing, revivifying force in nature, to whom of course is opposed the god of frost, ice and snow, ever blighting, as he does, young plants, the growing and budding darlings of *Yoskehä'*. It is, I believe, the reproductive, rejuvenating power in nature that is personified in *Yoskehä'*, and not the sun which is ever portrayed as retaining the full vigor of manhood, undiminished by the lapse of years.

Ta-wis'-ka-rä', Ta-wis'-ka-no', Tawiskaron (Brebeuf)
Sa-ie-wis'-ke-rat, or O-ha'-a.

This god, the twin-brother of *Yoskehä'*, is usually represented as the adversary of his brother and his unsuccessful imitator. The narration of the formation of man by *Yoskehä'*, detailing the abortive attempt of *Tawis'karä'* to do likewise, fashioning only monkeys, bats, owls and other uncanny things, such as the reptilia and the worms that live in the ground and those that mysteriously become moths and butterflies only to assume again the vermiform condition, is merely adversative to this assumed power of *Ta-wis'-ka-rä'* to do the things properly belonging to the character of *Yoskehä'*.

When, through the fostering care of *Yoskehä'*, the forests had become filled with various species of animals *Tawis'karä'* hid them in a vast cavern in the mountain side. But, noticing that the forests had become entirely free from game and animals, *Yoskehä'* sought them out and finding them opened the cavern, out of which they came forth. After the departure of *Yoskehä'*, *Tä-wis'-ka-rä'*, noticing the reappearance of the animals, hastened to the cavern and again closed it before all the animals had come forth. These that were again imprisoned in the cavern became transformed into the uncanny things that creep and crawl and live hidden in the ground and elsewhere, being regarded as possessing supernatural faculties. With the aid of his grandmother he spoiled in various ways the corn and bean crops of the Iroquois. These are some of the deeds of the despoiling and blighting *Tawis'karä'*.

With these preliminary remarks as to the character of *Tawis'karä'*, as narrated by the modern Iroquoian shamans as well as by the early Jesuit missionaries among the Hurons, attention will now be given to an attempt to analyze the names applied to this god.

The first to be considered is *Tawis'karä'* [*Thä-wis'-ka-rä'* and its cognate *Tawiskano'*, a contracted form of *Tawiskara'no'*] and *Saiewis'kerat*. The derivation of this name by Dr. Brinton from the word-sentence *tyo'karas* "it becomes dark," does not bear examination, having not a single element of probability, being purely fanciful. This, so far as I am aware, is the only attempt to analyze the expression.

From an examination of the terms which are apparently cognates, it is clear that the element common to them all is *-wis-kara-*. Now this is the noun *O-wis'-kä-ră'*, "hail, sleet." But this is merely a derivative cognate with *O-wis'-ä'*, "ice" and "glass-goblet." *U-wiç'-rĕ*, "snow" and "frost," the latter in Tuskarora. The final *-a-no'*, to the form *Ta-wis-ka-no'* for *Ta-wis-ka-ra'-no'*, is the adjective common to the entire group meaning "cold," the combination meaning freely the "cold" *Tawis'-ka-ră'*. The initial *t* here has to be explained in a manner very different from that followed in explaining the initial *t* of the name *Tha-ro^n-hyä-wä'-ko^n*; while the *a* is for *ha*, "he," the singular anthropic pronoun of

the third person. In some of the dialects an *s*, in others ç (like *th* in thin) which in rapid pronunciation is sometimes sounded like the interdental *t*. sound peculiar to many Indian tongues, is a prefix to proper nouns. The whole meaning "He is hail, is the hail," or, freely, "He who is the hail or ice." In *Sa-ye-wis'-ke-rat* wherein the pronoun is changed to the indefinite third personal singular of the anthropic gender, there is confirmatory evidence in support of the identification already indicated. The initial *sa* is the iterative affix, equivalent to the *re-* in re-gain, which it has already been said becomes expletive when the word-sentence becomes the name of an individual; the *ye* is the indefinite personal pronoun noted above, *-wis-kĕr* for *-wis·kăr-* is the stem of the noun *O-wis'-kă-ră'*, "hail, sleet," *at* is the obsolescent verb "to present, show, spread forth;" the word-sentence would therefore mean, freely, "he who spreads forth sleet, hail, etc."

If this analysis is a retracing of an historical product of linguistic activity, and I believe it is, then we see that *Tawis'-kară'* was so called because he spread forth hail, sleet and ice and the blighting frosts, because he was the cold ice-king, the enemy and despoiler of the planted crops of man, the failure or destruction of which being the extinction of the hope of future provision and the dreadful harbinger of famine and pressing want.

In some of the dialects of this family *Tawis'kara'* is also a name for the flintstone. This is to be explained perhaps, from the resemblance of this species of rock to ice; its fracture has very much the appearance of that of ice; its bluish or rather dark green color and seeming transparency assimilating it in other respects to that of ice.

In whatever *Tawiskară'* did, he was instigated and abetted by his grandmother *E-yă'-ta-hĕ^{n}'-tsik*, the goddess of night and the earth. The effects of frost and cold are best seen in the morning when the god of ice and cold has accomplished his nefarious work under cover of darkness.

In connection with what has already been said in explanation of the name and character of *Tawis'kară'*, it is necessary to note that the Onondagas apply the name *Ohă'ä* to him, and that this name is also a name for flint and that in a cognate rhotacist dialect it is, under slightly variant forms, a name for both *frost* and *flint;* I mean in Tuskarora, in which the word is *u-qnă'-rĕ*, meaning, "flint, a chip or fragment of shell or stone or pottery," showing that the Onondagas must have known the mythic connection between the flintstone and the frost-king. A cognate of *u-qnă'-rĕ* is *awĕ^{n}'ha rĕ* for **wa·ha'-rĕ*, signifying "hoarfrost, frost."

From the *Radices*, etc., of Bruyas, I select the following in support of the analysis offered above: *O-wise*, *gawisa*, "ice, hail, glass;" *owisk-ra*, Iroqæorum "hail, sleet;" *ga-wis-ke-rontion*, *ga-wis-ontion*, "it is hailing;" *watiowisk-wentare*, "it is covered with frost, with hoar frost."

Hĭ'-no^{n} — Ra-wĕñ-ni'-yo' — Ha-wĕñ-ni'-yo'.

Hĭ'-no^{n}' in the majority of the tribes of this family is the proethnic name of the god of thunder who, to promote the welfare of man, was ever en-

gaged in clearing the rivers, lakes and streams of the dreaded monsters, serpents and dragons and other nondescript goblins with which they were supposed to be infested. The Iroquois applied to him the esteemed title of grandfather. When they heard the first distant roll of thunder they cast sacrificial tobacco into the fire as an offering to him. The sound of thunder, it is said, is caused by his voice and the lightning is caused by merely knitting his august brows, for even such is the present meaning of the Tuskarora word for lightning, *nä-wa't ka-hrěq'-nä-riks*, which is composed of the initial *nä-*, the dual demonstrative meaning "two," but now merely expletive here, *wa-*, "it," the animate neuter singular third person of the personal pronouns, *ä' t*, the reflexive affix, having here a possessive function, meaning "his," *-kä-hrěq-n-* for *-kä hrě'-n-*, being the noun *o-kä-hrě'-ně*, meaning "eyebrow," *-rik*, signifying "to bite, seize, close," *-s*, the sign of habitual or customary action.

Along side of this name there exists the name *ra-wěñ-ni'-yo'* and in the non-rhotacist dialects *ha-wěñ-ni'-yo'*. This appellation is descriptive, referring to the *great voice* of the thunder-god. It is composed of *ra-* or *ha-*, the masculine singular third person of the anthropic gender, having here a possessive value, "his," *-weñn-* for *-wěñ-nä* from *o-wěñ'-nä'*, signifying "word, voice," and *-i-yo'*, which in modern Iroquois excepting Tuskarora means "fine, beautiful," but in Tuskarora it means "large, great," and there is abundant evidence in the other dialects that that is its original signification; hence, the whole synthesis signifies "his voice is great," and, freely, as an appellative. "he whose voice is great." This is clearly an expression wholly appropriate to none but the god of thunder; so that those writers who are satisfied with deriving this name from the French *le Dieu* and *le bon Dieu* are in error.

Owing to his great activity in watering the earth and in destroying the reptilian and draconic enemies of the human race he soon assimilated to himself a large share of the religious cult historically belonging to *Tha-roⁿ-hya-wä'-koⁿ* and *Yoskeha'*, just as Bel, the demiurge in Chaldean cosmology, displaced old El, the Ancient of Days; so that *Hĭ'-noⁿ'* acquired a preëminence that made him one of the most noted gods of the Iroquoian theogony.

GRAMMATIC FORM AND THE VERB CONCEPT IN IROQUOIAN SPEECH. By J N. B. HEWITT, Bureau of Ethnology, Washington, D. C.

[ABSTRACT.]

FORM as an element of grammatic and syntactic relation has been denied to the great majority of aboriginal American languages by William von Humboldt and his school of ultra-metaphysical tendencies. This school likewise denies to these languages the use of a true verb, yea, even concept of such a phenomenon. Humboldt, however, studied these the languages at second hand through most untrustworthy sources, having personally not the slightest skill to use any one of these languages he discussed. One of the unavoidable errors resulting from this inability, which

may serve as a fair example of his fallibility, is his unqualified adoption of Duponceau's erroneous statement regarding the characteristic methods of forming words and word-sentences in the aboriginal American languages, that such formation is accomplished in them by "putting together portions of different words, so as to awaken at the same time in the mind of the hearer the various ideas which they separately express."

Professor Hajjim Steinthal is the one man of our day who expounds and defends the fundamental doctrines of Humboldt which he has made his own. He has sought with more or less success to fathom the mysteries and to point out, either to puncture or to correct, the inconsistencies of his profound and wholly theoretical master. Neither arbitrary judgment nor misplaced acumen has been wanting in the process.

Professor Steinthal, following the lead of his great master, classes, with out the necessary preliminary study of those so classed, the great majority of the aboriginal American languages as "formless," because his master and prophet had spoken and said that true grammatic forms are developed in the "complete" inflectional languages only, namely, in the Indo-European and the Semitic, and that agglutinative and incorporative languages have not the genius to devise the morphologic means for the "expression of a true conception of one such form." Professor Steinthal, speaking in general of the aboriginal American languages and in particular of the Nahuatl, says that this language has in "its method of word-making, formed nouns, but *no true verbs*," for what at first sight might be called its verb is "merely a noun with a predicative prefix." Realizing that these views are mere possibilities (they have no right to figure as anything more), Professor Steinthal manages to concede a high degree of cunning and deception to these languages when he artfully says: "On the one hand these languages manage to make up for the lack of real form, by formations so artful that they quite acquire the appearance of real grammatical forms. The concealing disguise must be torn from these formations, in part by etymologic analysis, and more especially by an analysis of the structure of the sentence in general."

This sentence has the appearance of conveying profound wisdom; but, if I rightly construe its meaning, it has no intrinsic soundness, for its fatal weakness lies in the fact that it rests wholly on the unwarranted assumption that the people of a community remember the etymology of the words they employ in their daily conversation. The historical study of the development of language is opposed to such an assumption, disbarring as it does all lexic evolution. It was wrought to support certain conclusions deduced from misinterpreted facts; those conclusions must stand or fall without it.

J. Hammond Trumbull, the noted student of these languages, has, in a masterly article on the "Algonkin Verb," shown that the Algonquian tongue possesses not only a true verb but also true grammatic forms, thus impugning the soundness of the fundamental tenets of the Humboldt-Steinthal school as applied to this language. A similar study of the Iroquoian language as represented in its several dialects leads to conclu-

sions likewise adverse to the validity of the views of the Humboldt-following in regard to the lexic and structural processes prevailing in this and other American tongues. There are true grammatic forms in these dialects and they possess true verbs; the grounds upon which these have been denied are not sound, being due to misinterpretation of certain facts of grammar. By far the greater part of the nouns and adjectives in this language are derived from verbs, but the converse process is extremely rare, if such there be, for a single instance only is known to the present writer.

THE ALGONQUIAN APPELLATIVES OF THE SIOUAN TRIBES OF VIRGINIA. By WM. WALLACE TOOKER, Sag Harbor, N. Y.

[ABSTRACT.]

WHEN Captain John Smith and his companions first discovered the falls of the James river, in May, 1607, the native guides, who accompanied the explorers, related remarkable stories of a nation living further up the stream towards the mountains, called the *Monacans*, who, at the time of the falling of the leaf, came down and invaded their country. The fear of these western Indians was such, that no inducements the discoverers made could persuade these Powhatans to guide them to the habitations of these people. The stories, however, made so deep an impression upon the minds of the adventurers that, in the following spring, Captain Smith was assigned to the command of 60 men, in order to discover, and to search for the commodities of the *Monacans*, so as to load a ship for home. But so unseasonable was the time, and so opposed was the captain of the vessel to load with anything but the "phantastical gold" (as it is expressed), which he, as well as others, believed was obtainable among the *Monacans*, that it caused much ill-feeling to arise among the colonists; for Captain Smith, having been of a more practical and conservative nature than many of his associates, preferred to load the ship with cedar, which he justly claimed was a more "present dispatch than either durt or the reports of an uncertain discovery." After considerable delay the ship was finally loaded with cedar, and the attempt to discover the country of the *Monacans* was postponed. In the fall another effort was made, when Captain Newport with 120 men, went forth for the invasion of the unknown country. Arriving at the falls, they marched by land some forty miles in two days and a half, and then returned by same path. They discovered two towns of the *Monacans* called *Massinacack* and *Mowhemenchouch*.

Smith condenses the information which he subsequently gleaned from the natives as follows:—that upon the head of the Powhatans [James river] are the *Monacans*, whose chiefe habitation is at *Rasauwek*; unto whom the *Mowhemenchughes*, the *Massinacacks*, the *Monahassanughes*, the *Monasickapanoughs*, and other nations pay tribute. Upon the head of

the river of Toppahanock (Rappahannock) is a people called *Mannahoacks*. To these are contributors, the *Tauxanias*, the *Shackaconias*, the *Ontponcas*, the *Tegninateos*, the *Whonkenteaes*, the *Stegarakes*, the *Hassinnungaes*, and divers others, all confederate with the *Monacans*, though many different in language, and be very barbarous, living for the most part of wild beasts and fruits."

This brief summary embraces nearly all the knowledge that we possess relating to these tribes during the period of settlement; for, after 1609, although no doubt often in contact with the settlers, through trade and otherwise, nothing whatever was recorded or preserved relating to them for over sixty years. Even the significations of these tribal names—correct interpretations of which are absolutely necessary for an exhaustive and conclusive study of these people—have been forgotten for many generations.

The questions that now arise, and which I shall endeavor to answer, are these: First, what were the commodities of the Monacans, that Smith was instructed to search for? Second, what was it that gave rise to impressions in the minds of the Virginia colonists, that valuable mines of copper, iron, gold and silver, were to be found in the same region? Third, can any of the Mannahocks be identified with tribes of a later period? Fourth, of what language are these names of Captain John Smith?

The remainder of this paper is devoted to the study and interpretations of these names, showing that the term *Monacans* signifies the "diggers;" *Monahassanughes*, "people who dig in the rock, *i. e.*, in the steatite quarries;" *Monaacan'anough-rassauwek*, "home of the people who dig mica;" *Monasickapanoughs*, "people who dig the '*sickapan*', *i. e.*, the ground-nut" (*Apiostuberosa*); *Mowhemenchughes*, "those that gather fruit or berries." The term *Mannahocks*, however, was a collective one for the whole of this nation, and denotes "a very merry nation," or a people.

The interpretation of these Algonquian names of the Siouan tribes of Virginia—especially those bestowed by the Powhatans on the *Monacans*, who seem to have been more advanced in culture than the *Mannahocks*—throws considerable light upon their arts; identifies them with those people who supplied mica and other products to the mound-builders of the west; and, as many will admit, is another point added to the many, against the great antiquity of some, if not all, of these mounds.

[This paper will be printed in The American Anthropologist for October, 1895.]

THE MYSTERY OF THE NAME PAMUNKEY. By WILLIAM WALLACE TOOKER, Sag Harbor, N. Y.

[ABSTRACT.]

A MYSTERY unrevealed,—that intangible and illusive element, which environs the nomenclature, myths, customs, and traditions of the American Indian, will always remain a fount of the deepest interest, and closest study to the cultured mind of the critical student of the science of man.

The secret societies and sacred rites or mysteries of the priesthood of the red men has been the theme of many explorers into the wilderness of the science of anthropology for the past two decades or more. It is not my purpose at this time to single out, to compare, or to elaborate upon the symbolic customs or shamanistic ceremonies of the various stocks, tribes or clans which have been the basis for these essays. They can be found in the works of many noted specialists, where they may be read and studied in their entirety far better than in any brief abstract which I might quote. Many points of similarity can be traced—especially among tribes of Algonquian stock—revealing identity of thought occurring through hereditary transmissions and tribal borrowings in symbolizing animate and inanimate objects, also natural phenomena, in order to enable the priests to retain their supremacy over the superstitious minds of both the initiated and uninitiated members of the tribe. Every tribal family or clan undoubtedly had its society and priesthood, and it is my intention to demonstrate by historic and linguistic facts, that in the name Pamunkey, now designating a small tribe of Indians and a river of Virginia, we have a survival to our times of one of the reminders of an esoteric system, which existed among the Algonquian tribes of Virginia at the beginning of the seventeenth century. Not only does it hide a mystery, but the true interpretation, or signification of the name itself, has been, and still remains, a thing unknown—a mystery, which I shall endeavor to explain, I trust satisfactorily, so that it shall no longer exist as a problematical quantity in the synonymy of the tribes of the American race.

[This paper will be printed in The American Antiquarian for September, 1895].

A VIGIL OF THE GODS. By WASHINGTON MATTHEWS, M.D., and Maj. and Surg. U. S. A., Washington, D. C.

[ABSTRACT.]

THE paper describes the work of a single night (the fourth) of a great healing ceremony, lasting nine days, practised by the Navaho Indians and called by them Kleji Hathal, or the Night Chant. The night is devoted to a vigil resembling that of the mediæval knight over his armor, a vigil in which men and gods—or the properties representing the gods—alike take part. The rites show evidence of a belief in a community of interest and feeling between gods and men. A communal feast takes place, of a character somewhat akin to that of certain ceremonial acts performed among ourselves.

The work described lasts from about nine o'clock on the fourth night, till after dawn on the fifth day. Some of the occupants of the medicine-lodge stay awake all night, others may sleep a little; but, as a rule, the great majority may be found awake at any hour of the night.

Although the rites are important and interesting, they occupy but a

small portion of the time; the night is spent mostly in song. Songs of sequence, proper to the rites are sung; but songs from other rites are also admitted to entertain the watchers during the long vigil. Several long prayers are said.

The masks of the gods, twenty-one in number, are laid out on a buffalo robe in the northwest portion of the lodge, in an established order, and six ceremonies are performed over them at intervals, viz.: sprinkling them with pollen; sprinkling them with a cold infusion; feeding them; smoking to them; waking them, and praying to them.

The communal feast takes place before midnight. It consists of a bowl of thin, cold, corn-meal gruel. With this the gods are first fed; *i. e.*, morsels of gruel are laid on the mouth of each mask; and then everybody in the lodge takes four morsels from the bowl by dipping the tips of all his fingers in it.

Following this is another feast in which all the ancient dishes of the Navahoes—dishes of wild herbs and seeds now little used—are eaten; but only those who are hungry partake of this meal.

The ceremony of waking the masks occurs at midnight. A long song is sung in which all the gods are mentioned. When the singer names a god, he lifts the associated mask and shakes it as if waking the god. Each god has a separate stanza to himself. The refrain, Hyideznà, signifies, He stirs, He moves.

When it is near dawn, sacred cigarettes are taken out to be sacrificed to the gods. When dawn is announced, the shaman begins to sing the "Beautiful Dawn Songs" and he continues to lead in song for about an hour. Then he prays. Bags of pollen are passed around for all to help themselves, and the vigil is done.

Many minor observances of interest are omitted from this abstract.

[This paper will be printed in The American Anthropologist.]

AN OJIBWA TRANSFORMATION TALE. BY HARLAN I. SMITH, American Museum of Natural History, New York, N. Y.

[ABSTRACT.]

THE following transformation tale has been secured from an Ojibwa friend living at the "Poy-gan-ing" settlement. This place is on the eastern border of the large marsh which extends along the Saginaw River about half way between Saginaw and Bay City, Michigan.

"The robin was once an Indian youth. The parents of this young man made him a little bark house in which he fasted for about five days, when he became very hungry and asked for food. His parents begged him to wait three days longer. The next day towards evening he called for some red paint. His mother asked him what he was going to do with it, and obtained the paint for him. He rubbed it on his breast and said, 'I will be called Robin Redbreast forever.' He then flew away. His mother was crazed to see him leaving her in that manner, and followed him for a long distance hoping to catch him; but at last he became lost to sight in the distant sky."

The bark house is undoubtedly identical with the mystic hut of certain ceremonies of the Mide or Grand Medicine Society which is used for some of the incantations of the shaman. The fasting is an accompaniment of Mide initiations and ceremonies. The parents in wishing the youth to fast three days longer, desired him to continue to the end the ceremonies prescribed by the rules of their faith.

My friend also gives the following information: "In order to have the power of transforming one's self into an animal, the individual must fast five or eight days. After he has lain and fasted in the bark hut for this period he may have dreams of a prophetic nature, and that he is very old with grey hair and much knowledge. In the old times, if such a man could stand this ordeal of fasting, etc., for ten days he became a good shaman whose power the common Indian feared. If he became angry at any person he would transform himself into a bird or some other kind of animal, and go after the one he wished to injure on four alternate nights and at last kill him. All this was the way a long time ago more than it is now."

Although the narrator of this tale is able to speak and write English and attends the Indian Methodist Church, yet his strong belief in the truth of this tale was firmly impressed upon me.

Another version of this tale has been recorded by Henry R. Schoolcraft, who obtained it from the Ojibwa, under the title "Opeechee or The Origin of the Robin," on page 109 of his "Hiawatha," published in 1856.

THE DIFFERENT RACES DESCRIBED BY EARLY DISCOVERERS AND EXPLORERS. By Dr. STEPHEN D. PEET, Good Hope, Ill.

[ABSTRACT.]

THE Norsemen describe the Eskimos; Columbus, the Caribs; DeSoto, the Muskogees and Cherokees; the Spanish historians, the Aztecs and Mayas; the followers of Coronado, the Pueblos. A comparison between these different peoples would lead to a belief in the diversity of population, and variety of the races.

The different tokens found in the different parts of the continent confirm this impression. These and the different customs of the tribes, described by later historians, controvert the opinions of the linguists as to the unity of the American race.

THE PALEOLITHIC CULT. By Dr. STEPHEN D. PEET, Good Hope, Ill.

THE WORSHIP OF THE CARDINAL POINTS AMONG THE DIFFERENT AMERICAN TRIBES. By Dr. STEPHEN D. PEET, Good Hope, Ill.

VILLAGE LIFE AMONG THE CLIFF DWELLERS. By Dr. STEPHEN D. PEET, Good Hope, Ill.

OLD MOHAWK WORDS. By Rev. W. M. BEAUCHAMP, Baldwinsville, N. Y.

[ABSTRACT.]

THIS paper is suggested by a study of the Mohawk dictionary of Father Bruyas, compiled two hundred years ago. The words selected refer to customs obsolete or undescribed, and sometimes to those still existing in a modified form.

[This paper will be printed in The Journal of American Folk Lore.]

AN IROQUOIS CONDOLENCE. By Rev. W. M. BEAUCHAMP, Baldwinsville, N. Y.

[ABSTRACT.]

INDIAN chiefs are usually installed with much ceremony, but usually by the nation concerned. Among the Six Nations it is done by one of those not bereaved. There are two brotherhoods; the Elder and Younger Brothers, who respectively condole and raise chiefs for each other. This ancient ceremony is still retained, and was witnessed by me last April, when the Onondagas condoled the death of an Oneida principal chief, and raised one in his place. They sent the usual wampum invitation and loaned their village and council house for the occasion, the Oneidas now having none in New York. They and the Senecas, who are Elder Brothers also, met by the roadside and then marched to where the Oneidas sat by their wayside fire. There was much speaking and singing there and then the procession moved to the council house. The mourners took their places at one end and the condoling brothers at the other, the condoling song being continued. Then a curtain was hung, dividing the council house. Bunches of wampum strings were placed on a stick and the Onondagas sang over these. The curtain was removed, and the wampum gradually transferred to the Oneidas. The curtain was again hung, and similar songs followed. After the final removal of the curtain, the chief was installed with a presentation of wampum and suitable charges relating to his duties.

[This paper will be printed in The Journal of American Folk Lore.]

A MELANGE OF MICMAC NOTES. By STANSBURY T. HAGER, 372 Washington Ave., Brooklyn, N. Y.

THE Micmacs possess a system of measures for canoes, the elements of which have been drawn from the human body, and have been used from time out of mind. *Mooskunigun eaglooch*, the distance from finger tip to elbow, literally "the putting down of the elbow," measures the height of the canoe in front and rear. *Năoo wadegekul*, "four fingers' width," marks the difference in height between the successive *boonk*, or cross pieces, the height diminishing from ends to center. The distance between these cross

pieces is estimated by the *năooktoo-bilchasik*[1] or distance from the thumb to the tip of the extended forefinger plus the knuckles for remaining fractional parts. The center of the canoe is supposed to be higher than the ends by two fingers' width.

To assist them in counting, the Micmacs formerly used grains of maize. Their system of numeration is capable of indefinite extension. As to burial customs, in later times corpses were wrapped in skins and deposited in the ground, but the tradition of Cape Breton and of Nova Scotia proper agrees that formerly human bodies after death were cut in pieces; then the viscera were removed, the pieces were smoked and dried over a fire, were carefully sewn together again, closely wrapped in the best skins and furs obtainable and finally were deposited on the ground within the *kootoodakun-akade* or burial place. Some time ago a mummied head was found on the banks of the river Richibucto in New Brunswick.[2] These facts seem to suggest that a rudimentary mummying process has been in use more widely in America than has hitherto been supposed.

The " sweat house " of the western tribes was also in use amongst the Micmacs who called it *unkunumakun ōgoon*.

In former times each wigwam possessed two doors, one for each sex, and woe to the man who passed through the woman's door. All sorts of calamities would overtake him, and the method of cure was a laborious one. In general very exacting rules seem to have governed social intercourse between the sexes, and offences against social law were punished very severely.

A curious old custom was the kuniatijik, or song of need, which formed a very poetic substitute for barter and sale. Another was the *neskowadijik* or " dance of thanks " which expressed the gratitude of the guests for the feast provided by their host.

The Micmacs say that formerly they worshipped the rising sun and new moon, facing each for a few moments with arms extended and palms together. The cross was a sacred symbol amongst them, long before the coming of Europeans. The legend, told of its introduction, bears many marks of an indigenous origin. As to their present condition, while in some respects they are better off to-day than ever before, there are more than a few points, mental and moral, in which they were better before they had met with other races than their own.

SOME ARABIC SURVIVALS IN THE LANGUAGE AND FOLK-USAGE OF THE RIO GRANDE. By JOHN G. BOURKE, Captain 3rd Cavalry, U. S. Army, Fort Ethan Allen, Vermont.

[ABSTRACT.]

THIS paper contained a description of a few of the more noticeable Arabic "survivals" in the language, household customs and religious

[1] Năookt-" one." The names of these elements can only be used in composition with numbers.

[2] Smithsonian Reports, 1881, p. 675.

and festal ceremonies of the Mexican population of the Rio Grande Valley in New Mexico and Texas, as well as of the adjacent portions of the Territory of Arizona.

Many of the usages connected with the Feast of Saint John, in the month of June, and with Bull Fights, have undoubtedly been derived from Africa, through the Spanish Moors, and it was the purpose of this paper to make known exactly what these usages were.

[This paper will be printed in The Journal of American Folk-Lore.]

WORD-FORMATION IN THE KOOTENAY LANGUAGE. By DR. ALEXANDER F. CHAMBERLAIN, Clark University, Worcester, Mass.

[ABSTRACT.]

IN the Kootenay Indian language of southeastern British Columbia, the radical for "good" is *sōk* or *sūk*, and the idea of "good," as is often the case in the speech of primitive peoples, has extensions of meaning in the direction of "strong, brave," "nice, beautiful," "pleasant," etc. Following is a list of compounds in which the radical *sōk* appears:—

(1) *sṓk*-inē=he is good, hō-*sok*-inē=I am good; hō-*sūk*'natlā́enē=we are good.

(2) nā-*sṓk*-ē(n)=chief (lit. "he that is good, or strong"); ki-*sū́k*'kinṓkāyūk=*Arenaria pungens* (lit. "it has good, beautiful, flowers; *á̄qkinṓkāyūk* =flower); *sū́k*'kitlmā́kinē=corn-grain; gā-k*sū́k*-it (lit. "when things are getting warm, good)=summer.

(3) ki-*sū́k*'-yū́kiēt=good-day (*kīyū́kiēt*=day); hō-*sṓk*-ētlk·ṓkinē (lit. "I am pleased)=thank you; *sū́k*-itlqṓinē=he is well (lit. "he is good-bodied; *itlqṓ*=body); *sū́k*-itlwī́nē=he feels good (lit. "he is good-hearted"; *á̄qkitlwī́nam*=heart); *suk*-itlmḗyítinē=the weather is good (*á̄qkitlmḗyit* =sky, weather).

(4) tsitl-*sū́k*-inē=it is very good (*tsitl*=very); k'tsitl-*sū́k*-tlḗēt=a very good place (-*tlḗēt*=place?).

(5) *Sū́k*'nipḗ'k·ā (lit. "Good Spirit")=personal name of a Lower Kootenay Indian; k'*sū́k*in' (lit. "she who is good")=personal name of a Lower Kootenay Indian woman.

The radical for "bad" is *sān* and the following compounds illustrate its use:

(1) *sā́nē*=he is bad; hō-*sā́n-ē*=I am bad.

(2) *sā́n*-ink·ōk·ṓ'inē=the fire is low, does not burn well.

(3) *sā́n*-itlqōinē=he is sick; *sā́n*-itlwī́nē=he is angry; *sā́n*-itlmēyḗtinē = the weather is bad.

(4) tsitl-*sā́ha*-nē=it is very bad.

(5) *sán*-ūk·tlä́ᴇnt (lit. "Bad Clothes:" *ά́qkōk·tlά́ᴇnt*=clothes)=personal name of an Indian figuring in Kootenay legend.

When it is desired to be very emphatic, the vowels of *sōk* and *sān* are "long drawn out" or duplicated, thus: *sά́hānē*, or *sά́-a nē*="bad indeed;" *sō-ό́kinē*="good indeed," etc., the tone of voice being varied also.

For "bad" in the sense of "good for nothing," "worthless," there is another word, *tlitkᴇm*, the radical of which is the privative prefix *tlit*.

The interjection for "good!" is *ά́ hā hē' ī*, and for "bad!" *hā' iī*.

Sān and *sūk* (adjective-radicals) precede the noun-radical to which they are attached, as may be seen from the above examples. Following are examples of negative constructions: hṓ-k·ā-*sū́k*-inē=I am not good; hṓ-k·ā-*sά́hā-nē*=I am not bad. A few examples of sentences may be given: *sά́n*-e skinkūts=the coyote is bad; *sṓk*-inē tit'kat=the man is good; nipitinē nē-is (him) nā-*sṓk*-ēns=he kills (him) the chief; *sū́k*-inē sḗēt=the blanket is good; *sά́n*-ē ά́qk·ātl=the sack is bad; *sά́hān*-ē nā*sū́k*ē=he is a bad chief (the chief is bad); *sά́n*ink·ōk·ό́inē=the fire is no good (bad); *sū́k*-ēnk·ōk·ό́inē=the fire is good; kā́tlū́inē k'-*sά́han* qáqas=he thinks the skunk bad.

KOOTENAY INDIAN PERSONAL NAMES. By DR. ALEXANDER F. CHAMBERLAIN, Clark University, Worcester, Mass.

[ABSTRACT.]

As a small contribution to the semasiology of American languages, the following list of personal names of the Kootenay Indians of southeastern British Columbia may be of interest. Wherever ascertained, the etymological significations are noted.

(1) Names derived from or including animal-names: ***Skínkūts*** (coyote); *K·kά́tlsāᴇn mά́iyūk* (three weasels; ***Mά́iyūk***=weasel); ***Gōwitlk·ā kά́'kēn*** (big wolf); *Gōwítlk·tlē* (big horn sheep; *gōwitl*=big, ***āqk·tlē***=horn).

(2) Names derived from or including bird-names: ***K'kά́dlsά́ᴇnōkmά́ᴇnā*** (three bird tails; *aqkínōkmά́ᴇnām*=tail of bird); ***Giά́tlā nά́nā*** (little swallow).

(3) Names derived from names of insects: ***Djṓhōmin*** (pismire).

(4) Names derived from or including names of parts of the body and its various members: ***Māk'*** (bone); ***Aqk·ό́ktlā*** (skin); ***Tlitk·tlētl*** (blind; *tlit*=without, *āqk·tlētl*=eyes); ***K·ākū́mkāk*** (blind of one eye); ***Gōwṓktlū-tlά́qā*** (bearded; *ā́qk·ό́ktlūtlά́qā*=hair on the face); ***Gānū́qtlūtlōtlάqā*** (he has a white beard; *ákmnūqtlū*=white); ***Gā́tlᴇmά́'kāstlά́ᴇk·āk*** (he has big nostrils; *ά́qkāstlāᴇk·āk*=nostrils); ***Gānk·ά́tlāmά́tlāk*** (his head is hurt; ***ά́qktlām***

=head); *Kómătl k·ánkō* (Lame Knee, name of a character in Kootenay legend); *Kăntlúmtlăm* (curly head).

(5) Names referring to wearing apparel, articles belonging to the person, etc.: *Sánūk·tlăʀnt* (Bad Clothes, name of a character in Kootenay legend; *ăqkōk·tlăʀnt*=clothes; *Gíyūnătlăkō* (he has many pockets; *ăqkōtlăkō* =pouch, pocket); *Kăiykăktlăkō* (half pouch); *Tlúk·ătlăkō* (no pouch; *tlū* privative, *k·ă*=not).

(6) Names referring to personal character or peculiarities: *K'súkin* (good one; female name); *Képʀkă* (crazy, female name); *Kʀmătlēk* (he turns in his toes when walking; *aqktlēk*=foot); *K'súkwitl* (happy).

(7) Names referring to heavenly bodies: *Kămăktcē itlnóhōs* (yellow star; *ăqkitlnóhōs*=star).

(8) Names referring to minerals, metals, etc.: *Nókē* (stone); *nítlkō tlísēn* (iron paddle); *Măiyūk nítlkō* (weasel iron).

(9) Names referring to supernatural beings: *Súk'nipē'k·ă* (Good Spirit; *nipē'k·ă*=spirit).

Besides the above there are a number of names handed down from generation to generation, the exact meanings of which do not seem to have been preserved.

ANTHROPOMETRICAL OBSERVATIONS ON THE MISSION INDIANS OF SOUTHERN CALIFORNIA. By Dr. FRANZ BOAS, New York, N. Y.

DURING the past winter I visited the Mission Indians of southern California in order to study the distribution of types in that region. I was enabled to carry on this work by the aid of a grant of the American Association for the Advancement of Science.

The region under discussion is inhabited by tribes belonging to three distinct stocks: the Shoshonean, the Yuman and Mariposan. To the first named stock belong the Coahuila, Serano, Agua Caliente, San Luis Rey; the San Diego Indians belong to the Yuman and the Tule River Indians to the Mariposan. The Tule River call themselves TêXunē'ny.[1] The San Diego call themselves Tʀkuma'k; they call the Coahuila, Kaui'a; the San Luis Rey, Oxô'ē; the Agua Caliente, Xagua'tc; the Yuma, Gutcā'n. The Serano call themselves Mā'ringayam. The Agua Caliente call the San Diego, Gitcā'mkōtcʀm (cf. Gutcā'n above); the San Luis Rey, Qawi'qōtcʀm; the Coahuila, Tā'mikōtcʀm; and the Serano, Tamā'nqamyam.

The accompanying short vocabulary will be sufficient to show the relationships of these dialects and languages.

[1] The vowels have their continental sounds; ʀ obscure; ê = e in fell; î = i in hill; ô = o in German *voll;* â = aw in law; ä as in German *Bär;* ' pause; q velar k; x German ch in *ach;* x· German ch in *ich;* X intermediate between x and x·; ʟ dorso apical l; c = sh; ñ = ng in sing.

It appears from these lists that the Serano is less closely related to the other Shoshonean dialects than these are among themselves.

The following tables contain the results of the measurements taken by me. Besides these I have a number of measurements of statures which were taken by Mr. A. J. Street in 1892. I have embodied these in the tables which form the basis of our discussions.

The measurements of statures of the various tribes of this region give the following results:

STATURE OF MEN 20–60 YEARS OF AGE.

cm.	Coahuila.	Agua Caliente.	San Luis Rey.	Serano.	Tule River.	Total.
154	—	—	1	—	—	1
155	—	—	—	—	1	1
156	—	—	—	—	1	1
157	—	—	1	—	—	1
158	1	—	1	1	—	3
159	—	—	—	—	1	1
160	1	—	1	—	—	2
161	1	—	1	—	—	2
162	2	1	4	—	—	7
163	2	1	—	—	—	3
164	3	—	3	1	—	7
165	—	1	3	1	1	6
166	1	—	4	—	1	6
167	3	1	1	—	1	6
168	2	3	3	1	1	10
169	2	2	2	1	—	7
170	4	1	2	4	2	13
171	—	2	5	4	—	11
172	3	—	1	4	1	9
173	1	2	3	1	1	8
174	—	—	4	—	1	5
175	—	—	4	—	1	5
176	—	—	—	1	1	2
177	—	—	—	2	1	3
178	—	—	1	2	1	4
179	2	—	2	—	—	4
180	—	—	1	—	—	1
181	—	—	1	—	—	1
182	—	—	—	1	—	1
183	—	—	3	—	—	3
184	—	—	—	—	—	—
Average Cases	167.5 (28)	168.4 (14)	169.7 (52)	171.5 (24)	168.8 (16)	169.3 (184)

STATURES OF WOMEN 17–59 YEARS OF AGE.

cm.	Coahuila.	Agua Caliente.	San Luis Rey.	Serano.	Tule River.	Total.
145	—	—	2	—	—	2
146	—	—	—	—	—	—
147	—	1	1	—	1	3
148	—	1	—	—	1	2
149	—	—	—	—	2	2
150	1	—	—	—	1	2
151	—	1	—	—	—	1
152	—	—	1	—	2	3
153	3	3	3	—	—	9
154	3	—	4	—	1	8
155	2	2	2	—	1	7
156	2	2	2	—	—	6
157	2	1	5	—	1	9
158	4	1	4	1	—	10
159	2	1	2	—	—	5
160	1	3	2	—	1	7
161	—	1	4	—	1	6
162	—	1	3	—	—	4
163	—	—	3	—	2	5
164	—	1	2	—	—	3
165	1	1	—	—	—	2
166	3	—	1	—	—	4
167	—	—	1	—	—	1
168	—	—	—	—	—	—
169	1	—	—	—	—	1
170	—	—	—	—	1	1
Average Cases	158.0 (25)	156.7 (20)	157.6 (42)	158.0 (1)	155.3 (15)	157.2 (103)

This table shows that the statures of the tribes are nearly the same. The number of observations for each tribe is so small that the small variations in distribution may well be due to accidental causes. This is the more probable as the order of average statures is not the same in men and women of the various tribes. The conclusion seems justified that all these tribes are tall, the average stature of the men being nearly 1700 mm. The average stature of the women is 92.8% of that of the men. The distribution of statures, reduced to per cent, is given in the following table:

FREQUENCY OF STATURES.

Statures in cm.	Men.	Women.
144.5 — 146.4	—	1.9
146.5 — 148.4	—	4.9
148.5 — 150.4	—	3.9
150.5 — 152.4	—	3.9
152.5 — 154.4	0.8	16.5
154.5 — 156.4	1.5	12.6
156.5 — 158.4	3.0	18.5
158.5 — 160.4	2.2	11.7
160.5 — 162.4	6.7	9.7
162.5 — 164.4	7 5	7.8
164.5 — 166.4	9.0	5.8
166.5 — 168.4	12.0	1.0
168.5 — 170.4	14.9	1.9
170.5 — 172.4	14.9	—
172.5 — 174.4	9.7	—
174.5 — 176.4	5.2	—
176.5 — 178.4	5.2	—
178.5 — 180.4	3.7	—
180.5 — 182.4	1.5	—
182.5 — 184.4	2.2	—

The material is also sufficiently large to give a fair idea of the mode of growth of these Indians. For purposes of comparison I give a table showing the growth of the Indians of southern California, of tall Indian tribes, Halfbreeds and Whites, the latter being observations taken in Worcester, Mass.[1] The number of observations is given in parentheses.

[1] G. M. West. Anthropometrische Untersuchungen über die Schulkinder in Worcester, Mass. Archiv für Anthropologie, 1893, p. 85.

VOCABULARY.

ENGLISH.	COAHUILA.	AGUA CALIENTE.	SAN LUIS REY.	SERANO.	SAN DIEGO.	TULE RIVER.
man	na'xanic	naxa'nic	yaa'c *pl*.yā'yitcEm	wudjrī'tctc	iguī'tc	nâ'nô *pl*. nânē'E
old woman	nĭ'olnwĭl	——	——	——	——	——
ye	hêm	E'môm	Emô'm	mwō'han	minyawa'p	ma'ek
they	——	Exoa'tcim	——	——	bōp	——
one	su'pli	su'plo–it	supu'l	hōkp	êXī'nk	yêt
two	wi	wi	wê	wur	xawa'k	pô'nē
three	pā	pa	pā'hai	pā'hē	xamu'k	crâ'pīn
four	wi'tcu	wī'tu	wusa'	wô'tca	——	hôtpô'nē
five	nameqoa'na	——	mahā'l	mahā'tc	——	yētsinīLt
six.	kunsō'pElē	——	——	pa'rabrahē	——	ts'alī'px·
seven	kunwi'	——	——	wa'tckuwik	——	nô'mtsīm
eight	kunpā'	——	——	wā'utc	——	mô'n'as
nine	kunwi'tcu	——	——	ma'kowik	——	sopô'nôt
ten	naintcu'me	——	——	wā'hamatc	——	t'ē'ia
I eat	nowa'yīq	——	——	——	——	naaxatā'n
I laugh	nēsê'sEmqa	——	——	——	*sitting*	wulcä'x
I sleep	nēgō'pqa	——	——	——	——	wô'i'an
I cry	nīñgā'ñqa	——	——	——	——	——
my father	nê'na	nEtā'ta	nEna'	——	nyatā't	nim tē *my house*
thy "	ê'na	E'na	Ena'	——	mEtā't	mēn tē *thy house*
his "	hê'na	awatpE'na	puna'	——	batā't	——
our "	tcE'mna	tcamtcīmtā'ta	tcumna'	——	enyawapatā't	mayin tē *our house*
your "	ê'mna	Emumr'mna	umna'	——	nīmyawapatā't	mēnkē tē *your house*
their "	hê'mna	xoatcimbE'mna	pōmna'	——	bōpatā't	——
is that your father?	êtê'na	——	——	——	——	——
is that his father?	pêhê'na	——	——	——	——	——
						mā'gin tē *our two selves' house*
					dog	po's. *pl*. po's
					my dogs	nim po'swē
					who is that?	wa'tukt

V. SA

Number	
Tribe	
Name	
Age	
Height standing . .	
Height of shoulder .	
Length of arm . .	
Finger-reach . . .	
Height sitting . .	
Width of shoulders .	
Length of head . .	
Breadth of head . .	
Height of face . .	
Breadth of face . .	
Height of nose . .	
Breadth of nose . .	
Index of finger-reach .	
Index of arm . . .	
Index of height, sitting	
Index of width of should	
Length-breadth index .	
Facial ndex . . .	
Nasal index . . .	

[85] Sister of No. 181. [86] Si

AVERAGE STATURES.

Ages, years.	Boys. Mission Indians.	Boys. Tall Indian Tribes.	Boys. Halfbreeds.	Boys. Schoolchildren of Worcester, Mass.	Girls. Mission Indians.	Girls. Tall Indian Tribes.	Girls. Halfbreeds.	Girls. Schoolchildren of Worcester, Mass.
5	111.7 (3)	115.4	106.1	109.7	103.0 (3)	107.8	104.8	107.4
6	115.7 (9)	116 0	113.1	112.7	115.3 (6)	116.1	109.8	111.3
7	122.1 (16)	121.4	117.8	117.0	119.3 (13)	119.2	117.0	117.5
8	129.3 (21)	125.7	123.7	122.3	124.5 (12)	123.6	124.5	121.6
9	134.1 (22)	132.7	127.2	127.0	125.8 (14)	130.0	126.1	126.6
10	136.1 (14)	135.3	133.3	134.0	138.7 (9)	134.0	132.4	132.8
11	138.3 (15)	141.2	141.0	138.8	143.1 (10)	139.1	136.9	137.0
12	148.1 (28)	143.0	141.9	142.9	143.9 (17)	144.0	141.2	144.7
13	153.3 (13)	147.9	148.5	147.6	152.5 (17)	146.9	150.3	147.9
14	160.2 (13)	153.6	153.1	154.3	156.9 (18)	150.6	153.4	153.7
15	163.4 (18)	158.0	160.2	162.2	153.9 (16)	153.6	155.4	157.0
16	167.8 (21)	164.9	163.4	165.8	158.9 (16)	156.1	157.5	158.4
17	167.5 (19)	166.9	169.1	168.5	156.3 (12)	157.7	159.8	159.4
18	173.8 (9)	170.1	172.7	170.0	157.4 (16)	159.5	159.8	159.1
19	175.0 (6)	170.7	172.4	171.3		158.4	—	
20		172.2	171.8					
21		172.3	173.6					
Adult.	169.3 (134)	171.2	172.7	171.6	157.2 (103)	158.7	159.8	159.2

It appears from these tables that, although the adult white is taller than the Mission Indian, the reverse phenomenon is observed during the period of growth. The growing Indian child is throughout taller than the growing white child. The Halfbreeds take an intermediate position in this respect. The cause of this phenomenon lies in the fact that many Indian children reach the adult stage much earlier than white children. It seems that this acceleration depends on both race and climate, because the Mission Indians who inhabit a warm climate show the phenomenon much more distinctly than the tall Indians, who live mostly in northern latitudes.

The cause of the difference of the laws of growth for both races becomes particularly clear when we consider the variability of stature for each year. I have shown on a former occasion (Science, Vol. 19, p. 257) that, at the period when the amount of typical annual growth begins to diminish, the variability, which has been increasing up to that time, suddenly drops to much lower values. This drop in variability is, therefore, a better indication of approaching maturity than are the average statures, which, as I have shown at the place mentioned, cannot be considered typical values for the ages of growth. Among white children this sudden drop in variability occurs in the case of boys between the 15th and 16th years; in the case of girls between the 14th and 15th years. The following table will show that the sudden drop occurs among the Mission Indians in the case of boys between the 13th and 14th year, among girls between the 9th and 11th year.

AVERAGE VARIATION OF STATURE. CM.

Age, years.	Boys.	Girls.
5	5.7	3.3
6	2.3	3.1
7	6.1	4.5
8	4.8	6.5
9	4.9	*11.0*
10	5.6	7.6
11	*8.4*	4.3
12	5.9	5.6
13	7.1	4.5
14	3.8	3.3
15	4.9	4.5
16	3.4	3.2
17	2.7	2.7
18	3.1	4.1

It appears from these tables that the average age of maturity is from two to three years less than that of the Whites of the northern states. At the same time the variability in the time of reaching maturity seems to be greater, as otherwise it would be impossible that growth should continue as long as is expressed in the average values. This will appear still more clearly when the growth of the head measurements is considered.

I have also noted how many girls of different ages conveyed the general impression of being perfectly mature.

At	9	years,	1	among	9
"	10	"	0	"	5
"	11	"	0	"	7
"	12	"	0	"	10
"	13	"	3	"	7
"	14	"	9	"	13
"	15	"	4	"	7

As might be expected, the period during which girls are taller than boys occurs very early, namely, during the tenth and eleventh year.

The following table shows the growth of a few head measurements and indices which seem to be of interest. In these tables I have combined the years by twos as the number of observations for each year singly is too small.

AVERAGE MEASUREMENTS.

Ages, years.	Length of Head.		Breadth of Head.		Breadth of Face.		Facial Index.		Index of Finger-reach.	
	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.
6 and 7	176.4 (9)	169.4 (9)	143.7 (9)	139.3 (9)	122.4 (9)	120.1 (9)	80.4 (9)	81.7 (9)	100.9 (9)	102.4 (9)
8 " 9	176.3 (19)	173.3 (17)	146.2 (19)	142.1 (17)	127.8 (19)	123.0 (17)	82.3 (19)	83.7 (17)	102.8 (19)	102.6 (17)
10 " 11	175.4 (14)	176.8 (12)	145.1 (14)	145.5 (12)	127.1 (14)	130.6 (12)	82.5 (14)	82.4 (12)	102.3 (14)	103.5 (11)
12 " 13	179.5 (21)	177.4 (17)	148.5 (22)	147.0 (17)	133.8 (22)	133.7 (17)	83.8 (22)	85.0 (17)	103.4 (22)	104.5 (17)
14 " 15	181.8 (14)	178.5 (20)	152.8 (14)	147.2 (20)	140.0 (13)	134.2 (20)	86.8 (14)	84.7 (20)	105.0 (14)	103.9 (20)
16 " 17	187.1 (22)	185.1 (12)	152.4 (22)	150.0 (12)	141.5 (22)	140.0 (12)	85.8 (22)	83.4 (12)	104.5 (20)	104.1 (12)
18 " 19	191.1 (7)		153.7 (7)		145.3 (7)		85.4 (7)		106.4 (7)	

All these figures emphasize the result which was obtained above, namely, that many more individuals reach maturity at an early age than is the case among the northern Indians and still more than among the Whites of northern latitudes. It is a result of the very rapid development of the female sex that, at the age of 10 and 11 years, it exceeds in all its measurements the male sex. This phenomenon is not observed among the Whites of northern latitudes, where the head measurements of boys are always greater than those of girls, although an approach between the two takes place in the 12th year.

I have treated the head measurements of all these tribes together, as there are no appreciable differences of form. This is shown by the following table of length-breadth indices of the various tribes.

FREQUENCY OF LENGTH-BREADTH INDICES.

Length-Breadth Index.	Coahuila.	Agua Caliente.	San Luis Rey.	Serano.	San Diego.	Tule River.	Total.	Per cent.
71	—	—	—	1	—	—	1	0.5
72	—	—	—	—	—	—	—	—
73	—	—	—	—	—	—	—	—
74	—	—	—	—	—	—	—	—
75	2	—	1	—	—	—	3	1.6
76	2	—	1	—	1	—	4	2.1
77	4	—	1	—	—	1	6	3.1
78	8	2	5	—	4	—	19	9.9
79	7	—	5	1	3	—	16	8.4
80	7	—	4	1	3	—	15	7.8
81	9	2	2	5	1	—	19	10.0
82	9	2	11	3	2	2	29	15.2
83	5	1	5	2	7	1	21	11.0
84	8	—	4	1	6	2	21	11.0
85	2	—	2	3	5	—	12	6.3
86	5	1	1	2	2	—	11	5.8
87	4	—	1	—	1	—	6	3.1
88	1	1	—	—	—	—	2	1.0
89	3	—	—	—	—	—	3	1.6
90	1	—	—	—	—	—	1	0.5
91	—	—	—	—	—	—	—	—
92	1	—	—	—	—	—	1	0.5
93	1	—	—	—	—	—	1	0.5
Average	82.5	82.6	81.7	82.5	82.8	82.5	82.3	
Cases	79	9	43	19	35	6	191	

The most frequent index is 82, corresponding very nearly to that of the Yuma and Mojave. The Indians differ therefore entirely in type from the former inhabitants of Santa Barbara and of the islands of Southern California. The difference in type between these two neighboring peoples could hardly be greater than it is: the Mission Indians, tall, brachycephalic, with rather large and broad faces; the Indians of the islands, short, extremely dolichocephalic, with narrow faces and noses. It is of interest to note that a secondary maximum of frequency of the length-breadth index of the Mission Indians is found at 79, and that it is most strongly

developed among the Indians of San Luis Rey, who lived in the closest proximity to the long-headed islanders. It is quite probable that this maximum may be due to intermixture.

It is worth remarking that the Mission Indians whom we found to belong to one and the same physical type, belong to three distinct linguistic stocks, and that other members of the Shoshonean stock belong to quite distinct physical types. We have, therefore, in this region, another excellent instance of the fact that the same language may be spoken by people representing quite distinct types, and that people belonging to the same type may speak quite distinct languages, that is to say that linguistic classification and racial classification are by no means identical.

It remains to say a few words on the general appearance of the Indians. Their skin is very dark. I marked it generally as *33l* or *33m* of Radde's standard colors, but found the tint 33 not sufficiently reddish. Children show very frequently a certain degree of epicanthus which gives the eye a mongoloid appearance, but this feature is not as strong as I found it to be in British Columbia. The nose is very often concave, rather short, but wide with thick alæ. The lips are not as heavy as among the Indians who live near Columbia River. The lobe of the ear is better developed than among the Indians of Oregon and Washington. It is generally round and often detached. The hair turns gray very early. I recorded the cases in which there was a very strong mixture of white hair among the black, and found the following numbers:

Age, years.	Boys.	Girls.
7	—	1 among 7
8	—	—
9	2 among 10	—
10	—	—
11	—	—
12	1 among 17	—
13	—	—
14	2 among 9	—
15	3 among 4	—
16	3 " 9	2 among 3
17	3 " 13	—
18	2 " 5	—
19	1 " 2	1 among 1

Possibly the arid air of the desert may cause the hair to split and thus to turn gray, but as I have not made a miscroscopical examination of specimens, I am unable to tell with certainty the cause of the phenomenon.

THE SACRED POLE OF THE OMAHA TRIBE. By ALICE C. FLETCHER, Peabody Meseum, Cambridge, Mass.

IN the Peabody Museum of Harvard University have been placed, for safe keeping, the contents of two of the sacred tents of the Omaha tribe of Indians. The Sacred Pole and its pack were deposited in 1888, while the articles pertaining to the sacred tent of war were transmitted four years earlier, in 1884. These relics are unique and of rare ethnological value, and the relinquishing of them by their keepers is, I think, without historic parallel. It came about in this wise. When the changes incident to the impinging of civilization upon the Omahas made it evident to their leading men that ancient tribal observances were no longer possible, the question arose as to what should be done with the sacred objects that for generations had been essential in their ceremonies, and expressive of the authority of those charged with the administration of tribal affairs. To destroy these sacred articles was not to be thought of, and it was suggested that they should be buried with the chiefs of the gens charged with their keeping; which manner of disposal was finally determined upon.

At that time, I was engaged in a serious study of the tribe, and to me, it seemed a grave misfortune that these venerable objects should be suffered to decay, and the full story of the tribe be forever lost, for that story was as yet but imperfectly known; and, until these sacred articles, so carefully hidden, could be examined, it was impossible to gain an inside point of view whence one could study, as from the centre, the ceremonies connected with these articles and their relation to the autonomy of the tribe. The importance of securing these objects became more and more apparent, and influences were brought to bear upon the chiefs who were their keepers to prevent the carrying out of the plan for burial.

After years of labor, wherein large credit must be given to the late Joseph La Flesche, former head chief of the tribe, and to his son, the sacred articles were finally deposited in the Peabody Museum of Harvard University. The transfer was not effected without dramatic incidents evidencing the awe in which these objects were held—objects which, in their unpretending appearance, give little idea of the important part they have played in the history of more than one Indian tribe of our country.

The Omaha tribe is composed of ten Tŏñ-wŏñ-gdhŏñ or villages, to which for convenience sake we apply the term *gentes;* these camped in a fixed place, in a circular form, known as the Hu-dhu-ga, which had its opening to the east; five gentes camped along the line of the northern half and five along the southern half. When the tribe left their villages to go out upon the annual buffalo hunt, at which time they often travelled several hundred miles, the opening of the Hu-dhu-ga was always in the direction in which the tribe was moving; but the idea of orientation was never lost, for, if the people were going westward, the horseshoe-shaped Hu-dhu-ga turned as on a hinge placed opposite the opening, and the northern half, when the opening faced the east, was still the northern half, now

that the opening faced the west. In the mind of the people, the Hu-dhu-ga always opened to the east, and the tribe ideally faced the rising sun, wherever they pitched their tents.

The northern half of the Hu-dhu-ga was called In-shta-sunda, taking the name of the gens that camped at the northern point of the opening. The southern half was known as the Hõñ-ga-she-nu, from the Hõñga gens which occupied the middle place among the five gentes forming the south half. All the tents faced or opened toward the space enclosed by the line of lodges forming the Hu-dhu-ga.'

There were three tents set apart to contain the sacred objects of the tribe, known as the Dte-waghu-be, or sacred tents. One of these contained the paraphernalia of the ceremonies connected with war. This tent was pitched a short distance in front of those of the We-jin-shte gens, its keeper. This gens camped at the southern end of the opening, opposite the In-shta-sunda gens. The other two sacred tents were set side by side in front of the Hõñga gens, who had them in charge. The tent toward the west held the Hide of the White Buffalo Cow, and the tent cover was decorated upon the outside with stalks of corn in full ear In the tent towards the east were deposited the Sacred Pole and its belongings, and the decoration on the cover of the lodge was a number of round red spots.

These tents were objects of fear; no one unbidden went near them or touched them, and should any person or any animal or a tent pole come accidentally in contact with any of the three tents, the offending thing must be brought to the keeper, who would wash it with warm water, and brush it with a spray of artemisia, to prevent the evil that was believed to follow such profanation.

The Sacred Pole is of cotton-wood 2 m. 50 cm. in length and bears marks of great age. It has been subjected to manipulation; the bark has been removed, and the pole shaved and shaped at both ends, the top or "head" rounded into a cone-shaped knob and the lower end trimmed to a dull point. Its circumference near the head is 15 cm. 2 mm.; the middle part increases to 19 cm. and is diminished toward the foot to 14 cm. 6 mm. To the lower end is fastened, by strips of tanned hide, a piece of harder wood, probably ash, 55 cm. 2½ mm. in length, rounded at the top with a groove cut to prevent the straps slipping, and with the lower end sharpened so as to be easily driven into the ground. There is a crack in the Sacred Pole extending several cm. above this foot piece, which has probably given rise to a modern idea that this foot piece was added to strengthen or mend the pole when it had become worn with long usage. But the pole itself shows no indication of ever having been in the ground; there is no decay apparent, as is shown on the foot piece whose flattened top proves that it was driven into the ground. Moreover the name of this piece of wood is Zhi-be, leg, and as the pole itself represents a man and as this name Zhi-be is not applied to a piece of wood spliced on to a lengthened pole, it is probable that a foot piece was originally attached to the pole.

Upon this Zhi-be or leg, the pole rested; it was never placed upright, but inclined forward at an angle of about forty-five degrees and was held

firmly in place by a stick, tied to it about 1 m. 46 cm. from the "head." The native name of this support is I-mõñ-gdhe, a staff such as old men lean upon.

Upon the top or "head" of the pole was tied a large scalp, ni-ka nõñ-zhi-ha. About one end, 14 cm. 5 mm. from the "head" of the pole, is a piece of hide bound to the pole by bands of tanned skin. This wrapping covers a basket work of twigs and feathers lightly filled with the down of the crane. The length of this bundle of hide is 44 cm. 5 mm. and its circumference about 50 cm. But this does not give an exact idea of the size of this basket work when it was opened for the ceremony, as the covering has shrivelled with age, it being twenty years this summer since the last ceremony was performed and the wrapping put on as it remains to-day.

This bundle is said to represent the body of a man. The name by which it is known, A-khõñ-da bpa, is the word used to designate the leather shield worn upon the wrist of an Indian to protect it from the bow-string. This name affords unmistakable evidence that the pole was intended to symbolize a man, as no other creature could wear the bow-string shield. It also indicated that the man thus symbolized was one who was both a provider and a protector of his people.

The accompanying pack contained a number of articles which were used in the ceremonies of the Sacred Pole. This pack is an oblong piece of buffalo hide which, when wrapped around its contents, makes a round bundle about 80 cm. long and 60 cm. in circumference. It was bound together by bands of raw hide and was called Wa-dhi-gha-be, meaning literally, things flayed, referring to the scalps stored within the pack. Nine scalps were found in it when I opened the pack at the Museum, and some of them show signs of considerable wear; they are all very large and on one are the remains of a feather, all of which has been worn away but the quill.

The pipe belonging to the pole and used in its rites was kept in this pack. The stem is round and 89 cm. in length. It is probably of ash, and shows marks of long usage. The bowl is of red catlinite, 12 cm. 5 mm. at its greatest length and 7 cm. 2 mm. in height. The bowl proper rises 4 cm. 5 mm. from the base. Upon the sides and bottom of the stone certain figures are incised which are difficult to determine; they may be a conventionalized bird grasping the pipe. The lines of the figures are filled with a semi-lustrous black substance composed of vegetable matter which brings the design into full relief; this black substance is also painted upon the front and back of the bowl, leaving a band of red showing at the sides. The effect is of a black and red inlaid pipe. When this pipe was smoked the stone end rested on the ground; it was not lifted but dragged by the stem as it passed from man to man while they sat in the sacred tent or enclosure. To prevent the bowl falling off, which would be a disaster, a hole was drilled through a little flange at the end of the stone pipe where it is fitted to the wooden stem, and through this hole one end of a cord made of sinew was passed and fastened, and the other end

of the cord securely tied about the pipe stem 13 cm. above its entrance into the stone pipe bowl.

The stick used to clean this pipe, Ni-niu-dhu-ba-thki, was kept in a case or sheath of reed wound round with a fine rope of human hair, which was fastened with bits of fine sinew; a feather, said to be that of the crane, was bound to the lower end of this sheath. Only a part of the quill remains. Sweet grass, Pe-zthe-zthōñ-thta, and cedar, ma-zthi, broken up and tied in bundles, were in the pack. Bits of the grass and cedar were spread upon the top of the tobacco when the pipe was filled, so that when it was lit these were first consumed, making an offering of savory smoke.

Seven arrows, Monpe-dhum-ba, were in the pack. The arrow shafts are much broken; they were originally 45 cm. 6 mm. in length, feathered from the crane, and had stone heads. Part of the quills of the feathers remain, but the arrow heads are lost. A bundle of sinew cord, red paint Wa-the-zhi-de, used in painting the pole, and a curious brush, complete the contents of the pack. The brush is made of a piece of hide, one edge cut into a coarse fringe and the hide then rolled together and bound with bands, making a rude utensil with which the paint, mixed with buffalo fat, was put upon the pole.

Those who may visit the Peabody Museum at Harvard University will notice upon the upper portion of the Sacred Pole something that looks like pieces of thick bark; it is the dried paint that remains from the numerous anointings of the pole, which ceremony was a thank offering for successful hunts and a prayer for future prosperity. The anointing or painting of the pole took place in July toward the close of the annual buffalo hunt after the tribe had reached that portion of their hunting grounds where they felt themselves reasonably secure from their enemies. The custom long ago, beyond the memory of the oldest man, so I was told by the chief of the Hōñga in 1888, was to perform this ceremony twice a year after the summer and winter hunt, but, within his memory and that of his father, it had been held only in the summer.

The rapid destruction of the herds of buffalo in the decade following 1870 caused the Indian not only sore physical discomfort, but also great mental distress. His religious ceremonies needed the buffalo for their observance, and its disappearance, which in its suddenness seemed to him supernatural, has done much to demoralize the Indian, morally as well as socially. No one can have his sacred rites overturned in a day and preserve his mental equipoise.

After several unsuccessful hunts of the tribe, poverty succeeded to their former plenty, and, in distress of mind and body, seeing no other way of relief, the people were urged to the performance of their ceremony of Anointing the Pole, although misfortune in hunting had made this in its integrity impossible. A new plan was suggested by which the ceremony could be accomplished and, as they fondly hoped, the blessing of plenty be restored to the people. The tribe had certain moneys due from the U. S. in payment for ceded lands, and through their agent they asked that

such a sum as was needful to purchase thirty head of cattle should be paid them. The agent, little understanding the trouble of mind of the Indians under his charge or the motive of their request, wrote to the Interior Department of Washington, that "The Omahas have a tradition that when they do not go on the Buffalo Hunt, they should at least once a year take the lives of some cattle and make a feast." This interpretation of the Indian's desire of spending his own money for the purchase of the means by which he hoped to perform rites that might bring back the buffalo and save him from an unknown and terrifying future, is a significant comment on how little the Indian's real life had been comprehended by those appointed to lead him along new lines of living and thinking. The cattle were bought at a cost of about $1000. The ceremony took place; but alas! the conditions did not alter. A second time the tribe spent its money, but to no avail. New interests and influences grew stronger every month. The old customs could not be made to bend to the new ways forced upon the people. Opposition to further outlay arose from the government and amongst some of the people; and one year, two years, three years passed and the Pole stood silent in its tent, dreaded, as a thing that was powerful for harm, but seemingly powerless to bring back the old time prosperity to the people.

When, in 1888, the Pole was finally placed for safe keeping in the Museum at Harvard University, it seemed very important to secure its legend, known to the chief of the Hŏñga. The fear inspired by the Pole was such that it seemed as though it would be impossible to gain this desired information, but it was finally brought about; and one summer day in September, the chief, Shu-de-na-zhe, came to the house of Joseph La Flesche, to tell the tradition of his people treasured with the legend of the Pole.

It was a memorable day; the harvest was ended and tall stacks of wheat cast their shadows over the stubble fields that were once covered with buffalo grass. The past was irrevocably gone. The old man had consented to speak but not without misgivings, until his former head chief cheerfully accepted for himself any penalty that might follow the revealing of these sacred traditions, which was held to be a profanation punishable by supernatural means.

While the old chief talked he continually tapped the floor with a little stick he held in his hand, marking with it the rhythm peculiar to the drumming of a man who is invoking the unseen powers, during the performance of certain rites. His eyes were cast down, his speech was deliberate, and his voice low, as if speaking to himself alone. The scene in that little room where we four sat was solemn, as at the obsequies of a past once so full of human activity and hope. The fear inspired by the Pole was strengthened in its very passing away. By a singular coincidence the touch of fatal disease fell upon Joseph La Flesche almost at the close of this interview, which lasted three days, and in a fortnight he lay dead in the very room where had been revealed the legend of the Pole.

According to the legend, the appointed time for the ceremony of

Anointing the Pole was in the moon, or month, when the buffalo bellow, the latter part of July. It was to follow the fourth tribal chase after the ceremony of the taking of twenty buffalo tongues and one heart had been performed four times. Then the Wa-ghdhe-ghe-tŏñ subdivision of the Hŏñga gens, which had charge of the Pole, called the seven principal chiefs, who formed the oligarchy, to the sacred tent to transact the preliminary business. They sat there with the tent closed tight, clad in their buffalo robes, worn ceremonially, the hair outside and the head falling on the left arm; they smoked the pipe belonging to the Pole, and ate the food provided, in a crouching attitude, and without a knife or spoon, in imitation of the buffalo's feeding, and took care not to drop any of the food. Should, however, a morsel fall upon the ground, it was carefully pushed toward the fire; such a morsel was believed to be desired by the Pole and, as the legend says, "no one must take anything claimed by the Pole."

When the council had agreed upon the day for the ceremony, runners were sent out to search for a herd of buffalo, and, if one was found within four days, it was accounted a sacred herd, and the chase that took place provided fresh meat for the coming ceremony. If, however, within four days, the runners failed to discover a herd, dried meat preserved from their previous hunts was used.

In this preliminary council, each chief, as he took a reed from a bundle kept in the sacred tent, mentioned the name of a man of valorous exploits. When the number of brave men agreed upon had been mentioned, the Hŏñga gave the reeds to the tribal herald to distribute to the designated men, who, on receiving them, proceeded to the Sacred Tent, and by giving back to the Hŏñga their reeds, accepted the distinction conferred upon them. It was now their duty to visit the lodges of the tribe and select from each tent a pole to be used in the construction of a lodge for the ceremonies. This they did by entering the tent and striking the chosen pole, while they recounted the valiant deeds of their past life. These men were followed by designated men from the Hŏñga gens, with their wives, who withdrew the selected poles and carried them to the vicinity of the sacred tent, where they were set up and covered so as to form a semicircular lodge. It was erected upon the site of the Sacred Tent, which was incorporated in it, and opened toward the centre of the tribal circle; and, as the poles taken from all the tents in the tribe were used in its construction, this communal lodge represented the homes of the people.

Up to this time the tribe may have been moving and camping every day, but now a halt is called until the close of the ceremony. To the communal tent the seven chiefs and the headmen are summoned by the Hŏñga and take their seats, all wearing the buffalo robe in the ceremonial manner. The herald on this occasion wears a band of matted buffalo-wool about his head with a downy eagle feather standing in it.

The Sacred Pole is brought forward to the edge of the communal lodge so as to lean out toward the centre of the Hu-dhu-ga. In front of it a circle is cut in the ground, the sod removed, and the earth made loose and fine.

From this time to the close of the rites, all the horses must be kept outside the Hu-dhu-ga, and the people must not loiter in or pass across the enclosure. To enforce this regulation, two men were stationed as guards at the entrance of the tribal circle.

The pipe belonging to the Sacred Pole is smoked by the occupants of the communal tent, and the bundle of reeds brought. Each chief, as he draws the reed, mentions the name of a man, who must be one who lives in his own lodge as the head of a family, and not a dependent upon relatives (what we would term a householder). As the chief speaks the name, the herald advances to the Pole and shouts it aloud so as to be heard by the whole tribe. Should the name given be that of a chief, the herald will substitute that of one of his young sons. The man called is expected to send by the hand of his children the finest and fattest piece of the buffalo meat, of a peculiar cut known as the te-zhu. If the meat is too heavy for the children, the parents help to carry it to the communal tent. The little ones are full of dread, and particularly fear the fat which is to be used upon the Pole. So, as they trudge along, every now and then they stop to wipe their wee fingers on the grass so as to escape any blame or possible guilt of sacrilege.

Should any one refuse to make this offering to the Pole, he would be struck by lightning, be wounded in battle, or lose a limb by a splinter running into his foot.

The gathering of the meat occupies three days, during which the Hōñga are singing at intervals, by day and night, the sacred songs, which echo through the camp and enter into the dreams of the children.

The songs belonging to the ritual of the corn are first sung, followed by those relating to the hunt, all in their proper sequence. If a mistake in the order is made, the Hōñga lift up their hands and weep aloud, until the herald, advancing from the Sacred Pole, wipes away the tears with his hands and the wail ceases, and the songs go on.

On the morning of the fourth day the meat is spread upon the ground before the Pole in parallel rows, the full length of the communal lodge. The keeper of the Pole and his wife then advance to perform their part in the ceremony. He is clothed in the usual shirt and leggings and his cheeks are painted in red bands. The woman wears over her gala dress a buffalo robe with the skin outside which is painted red; so are her cheeks, and bands of the same color are on her glossy, black hair, and to the heel of each of her moccasins is attached a strip of buffalo hair, like a tail.

Songs precede and describe every act of the keeper. When he is about to cut the fat from the meat offered to the Pole the Hōñga sings the Song of the Knife, and, at the fourth repeat, the keeper grasps the knife. So, on the fourth repeat of another song, he cuts off the fat, and lays it in a large wooden bowl which is carried by his wife. In this vessel the soft fat and a peculiar clay made red by baking are kneaded into a paint, with which the keeper smears the pole.

In the circle excavated in front of the Pole, a buffalo chip is kindled and sweet-grass and cedar leaves laid upon it, through the smoke of which the seven arrows are now passed for purification and consecration. The

leather covering is removed from the body of the Pole, and the woman comes forward and thrusts the seven arrows, one by one, through the basket-work thus exposed. Each arrow has its special song. If an arrow passes clean through, and falls so as to stand in the ground, all the people shout for joy, as this indicates special victory in the war and success in hunting.

Now, the buffalo meat is gathered up and laid away, and four images are made of grass and hair and set up before the Pole. These are to represent enemies of the tribe. Then the herald goes forth shouting: "Pity me, my young men, and let me once more complete my ceremonies;" meaning by this that the men of the tribe should lay aside all other affairs and considerations and devote themselves to the part they were to play in the final act of the ceremony.

While the warriors are putting on their ornaments and their eagle-feather war-bonnets, and getting their weapons in order for a simulated battle before the Pole where they should act out in detail their past brave deeds of war, the people crowd together at either end of the communal tent as to a vantage point whence to view the dramatic spectacle.

Some of the warriors appear on horseback outside the camp and charge upon it, crying out, "They have come! They have come!" (This was once done in so realistic a manner as to deceive the people into the belief of an actual onslaught of an enemy, to the temporary confusion of the whole tribe.) The warriors fire upon the images before the Pole, and the chiefs within the communal tent shoot back in defence of them; this charge is made four times and then the images are captured and treated as conquered. With this stirring drama, which is called "Shooting the Wa-ghdhe-ghe," or Pole, the ceremonies come to an end, which ceremonies, according to the legend, were instituted "to hold the people together."

On the following day the He-di-wa-chi, under the leadership of the In-ke-tha-be gens, takes place. This is participated in by all the tribe, men, women and children. The He-di-wa-chi is a dance about a pole, which has been cut and painted for the occasion with peculiar ceremonies. After this dance the camp breaks up, each family following its own pleasure, and all rules and regular times as to hunting are at an end for the season.

The legend states that the finding of the Pole occurred while a council was in progress among the Cheyennes, Arickerees, Pawnees, and the Omahas, which then included what are now the Ponka and Iowa tribes. The object of the council was to agree upon terms of peace and decide upon rules of war and hunting.

The legend runs as follows: "During this time a young man who had been wandering came back and said: 'Father, I have seen a wonderful tree!' and he described it. The old man kept silent, for all was not yet settled between the tribes.

The young man went again to visit the tree, and on his return repeated to his father his former tale of what he had seen.

The old man kept silent, for the chiefs were still conferring.

At last when everything was agreed upon between the tribes, the old man sent for the chiefs and said:

"My son has seen a wonderful tree. The thunder birds come and go upon this tree, making a trail of fire that leaves four paths of burnt grass toward the four winds. As the thunder birds light upon the tree, it bursts into flame and the fire mounts to the top; still the tree stands burning, but no one can see the fire except at night."

When the chiefs heard this tale, they sent runners to see what it might be, and the runners came back and told the same story,—how the tree stood burning in the night. Then all the people had a council, and they agreed to run a race for the tree and attack it as if it were an enemy. The chiefs said: "We shall run for it; put on your ornaments and prepare as for battle."

So the young men stripped and painted themselves, and put on their ornaments, and set out for the tree, which stood near a lake. The men ran and a Ponka reached it first and struck it, as he would an enemy.

Then they cut the tree down and four men, walking in line, carried it on their shoulders to the village. And the people sang four nights, the songs which had been composed for the tree, while they held their council. The tree was taken inside the circle of lodges and a tent was made for it. The chiefs worked upon the tree, and shaped it and called it a human being. They made a basket-work of twigs and feathers, and tied it on the middle of the pole for a body. Then they said: "It has no hair!" So they sent out to get a large scalp, and they put it on the top of the pole for hair. They sent out a herald to tell the people that when all was completed they should see the pole.

Then they painted the pole and set it up before the tent, leaning on a staff, and called all the people; and all the people came,—men, women and children. When all the people had gathered, the chief stood up and said:

"You now see before you a mystery. When we are in trouble we shall bring our trouble to him. To him you shall make your offerings and requests; all your prayers must be accompanied by gifts. This (pole) belongs to all the people, but it shall be in the keeping of one family, and the leadership be with them, and if anyone desires to lead (*i. e.* become a chief and take responsibility in the governing of the people), he shall make presents to the keepers, and they shall give him authority."

When all was finished, the people said, "Let us appoint a time when we shall again paint him, and act before him the battles which we have fought." So the time was fixed in the moon when the buffaloes bellow.

Then follow the details of the ceremony already outlined, ending with the words: "This was the beginning of the ceremony, and it was agreed that it should be kept up."

The legend goes on: "The people began to pray to the Pole for courage and for trophies in war, and their prayers were answered. The Pole is connected with thunder and war, the authority of the chiefs and of the hunt."

At the time when the Pole was discovered, both the tradition of the

Omahas and the Ponkas concur in stating that the people were living in a village near a lake, and that the tree, which was evidently some distance from the camp, grew near a lake. The exact position of this village is not yet identified, but it was in all probability at no great distance from the Red Pipe stone quarry in the southwestern part of South Dakota.

Time forbids an enumeration of my historical researches in this connection, but the oldest records and authentic maps indicate that the Pole could not have been cut at any time since 1673.

The establishment of the order of chieftainship and the government of the tribe, as it has been known during the present century, antedated the institution of the pole. Several political changes had already taken place before that event.

I cannot at this time recount and analyze the Legend of the Seven Old Men, who are said to have instituted the government by seven chiefs, and to have established the Ni-ni-ba-tõñ or pipe subgens in certain of the ten gentes of the tribe. This legend deals with a political change and a religious innovation that long antedated the advent of the Sacred Pole. When the seven old men introduced the sacred tribal pipes, there were already in the tribe three distinct groups of insignia of as many forms of worship, namely:

The four sacred stones, in the custody of the Ma-thiñ-ga-ge-he gens, having their peculiar ritual.

The Honor Pack, the Sacred Shell and the Pole of Red Cedar, of the Thunder Rites, in charge of the We-jin-shte gens; and

The songs and ritual of the Hede-wache, committed to the Inkethabe gens.

The entrance of the Omahas into the group of tribes that agreed to respect and to observe the ceremony of the Wa-wañ—Pipes or Calumets of Fellowship— not only tempered their sun worship through the teachings of the ritual of this ceremony, but opened a new path to tribal honor, by which a man of valor and industry could reach equality with the hereditary chiefs in the government of the tribe. The sacred ritual pipes had the same function within the tribe, as the Wa-wañ or Calumets of Fellowship had between different tribes, and they also were ornamented with the peculiar woodpecker heads, the upper mandril turned back and painted in the same manner as upon the Fellowship Calumets. Upon one of these tribal pipes seven of these heads were placed in a row, referring to the seven chiefs; on the other pipe there was but one head, symbolizing the unit of authority which must be reached by unanimity of the seven chiefs in all decisions.

Poles had long been used in the tribe as symbols of religious beliefs and of authority.

The He-di-wa-chi and its pole bear evidence of great age, and it seems not improbable that it sprang from the same root as the Sun Dance of the Dakotas which has developed so differently.

The Pole of the Thunder rites, belonging to the Sacred Tent of War, in the care of the We-jin-shte gens, was of red cedar, 1 m. 25 cm. in length,

to which was corded a Zhi-be or leg, 61 cm. long. A rounded stick like a club 43 cm. long, also of red cedar, was bound about the middle of the pole. The Thunder gods used clubs as weapons; one of the ritual songs of the Tent of War says: "Your grandfather, fearful to behold is he! When your grandfather lifts his long club, he is fearful to behold!" In olden time, when the rites were performed in the spring when the first thunder peal was heard, a part of the ceremony was the painting of this pole.

It is probable that this pole was the prototype of the Sacred Pole: the two have features in common: the Zhi-be or leg; the body on the one being the thunder club, and on the other bearing the name of the bow shield, used by warriors to protect the wrist from the bow-string; both poles were painted with due ceremony at appointed times; both referred more or less directly to thunder, and any profanation of either was avenged by that power, the guilty being struck by lightning. It will be recalled that attention was first drawn to the tree, from which the Sacred Pole was shaped, by the thunder birds coming to it from the four quarters and the mysterious burning that followed; so that the pole became, in the minds of the people, endowed with supernatural power by the ancient thunder gods.

The government by the seven chiefs was at first confined to hereditary rulers, drawn from certain subdivisions of certain gentes. By a slow process in the course of time men of ability rose into power, and honors were won and worn by those whom the people recognized as leaders, until, at last, the oligarchy of seven became representative of individual attainment, and of gentes and sub-gentes hitherto debarred from particicipation in the governmental affairs of the tribe.

The name given to the Sacred Pole, Wa-ghdhe-ghe, bears testimony to this political change in the chieftainship. Wa-ghde-ghe is made up of the prefix wa-, indicating the power to do, and ghdhe-ghe, the name of the ceremony of placing the mark of honor upon the daughter of a chief. (This consisted in tattooing a small round spot about half an inch in diameter upon the forehead, and, upon the chest and back, just below the neck, a circle with four equidistant points projecting from it. These symbols refer to the sun and the four quarters.) The right to put the mark of honor upon a daughter was not hereditary, but could be gained through the performance of one hundred certain deeds, called Wa-dhiñ-e-dhe. The name of the pole, Wa-ghdhe-ghe, signifies the power to do, or perform this ceremony, ghdhe-ghe, the mark of honor.

The Sacred Pole of the Omahas was, as we have seen, scarcely an innovation as a symbol, although it stood for the authority of new ideas that had been slowly developing within the tribe. In it and its ceremonies nothing that had been gained in the past was lost, the supernatural control of man was recognized, together with his ability to achieve for himself honor and rank. It stands as a witness that society, even in its primitive tribal conditions, is not an inert mass of people, but an organization operated upon by laws kindred to those which we have learned to recognize as instrumental in the unfolding of the mind of man.

INDIAN SONGS AND MUSIC. By ALICE C. FLETCHER, Peabody Museum, Cambridge, Mass.

IT is well known to those familiar with our North American Indians that every important act and every ceremony has its appropriate music; rituals are imbedded in it; warriors are stimulated by it; youth and old age seek expression through it; so that a collection of the songs of a tribe exemplifies the emotional life of the people.

It has been suggested that these songs were generally improvised, and that one seldom hears a song rendered twice alike; but, from extended observation covering many years and many tribes, I am convinced that the supposition is a mistake. The songs of a tribe are handed down with care, and the rituals are taught to those entitled to initiation, or who have the hereditary right to learn them. The various societies have their special songs, which are transmitted by official keepers who are always men possessing musical gifts who take pride in their exactness of memory. The same is true of game songs and of others that relate to social customs. I have found it a rule among Indians that no one will venture to sing a song in the presence of other Indians if he is not sure that he can render it correctly, for a mistake subjects him to unmerciful ridicule. Of course songs which are sacred, or are private property, are never heard in public.

Many of the songs I have transcribed are undoubtedly very old. It is probable that the Omaha prayer, or "Cry to Wa-kõñ-da," echoed through this broad land, when its hills and woods were indeed a terra-incognita to our race. While there are many songs preserved, because of their connection with rituals and sacred rites, or because of their power of expressing emotion, these old songs are not the only ones to be heard, for the art of song making is not yet lost. A good, new song finds its way among the Indians almost as rapidly as with us, and, when men visit from one tribe to another, one of the pleasures of home-coming is to be able to bring back a new song. Songs, therefore, travel far, but it is always remembered where the song started, and credit is given to the tribe where it originated.

The difficulties that attend the collecting of Indian songs are many, and I am indebted for much of my success in the pursuit of this study to my collaborator, Mr. Francis La Flesche. While some ceremonies are quite free to the public, and the music easily obtained, there are others to which it is almost impossible to gain entrance and their ritual is kept a secret. Songs that pertain to individual experience are seldom heard; for it is not easy to gain the confidence of the Indian or to get near enough to the people to observe them without restraint.

It has been asserted upon good authority that there are no love songs among the Indian tribes. Songs, as Herbert Spencer defines them, "commenced by a man to charm a woman." The statement is a mistake, but it is one easily made, for a person could live years in a tribe and never

chance to hear one such song, as Indians are particularly shy concerning all such matters.

There is, however, a class of songs which celebrate so-called love adventures. These are sung exclusively by men and never in the presence of women. But although women never hear these songs and seldom know of their existence, strangely enough the gallant who composes the words makes the woman appear to be the narrator of the story. These derisive songs are familiar to white observers, and have given rise to the opinion that they are the only love songs among the Indians. The fact is, that these "Woman-songs," as the Omahas call them, are not in any sense love or courtship songs.

To record Indian songs from memory is very difficult, and the task of securing frequent repetitions of songs is often one requiring much diplomacy. Graphophonic records are exceedingly helpful, but they require verification by the human ear. I have found it quite important in taking records, both by the ear and by the graphophone, to secure a number of singers, so that a volume of sound should be produced; this is particularly necessary when testing the accuracy of the notation of a song.

In the monograph entitled, A Study of Omaha Indian Music, published by the Peabody Museum of American Archæology and Ethnology, of Harvard University, Cambridge, Mass., I have spoken in detail of the Indian's mode of singing, of the absence of a standard pitch, and of other characteristics. I will at this time refer only to their marked rhythm. Many Indian songs are accompanied by movements of the body, so that the eye as well as the ear is arrested by the strongly accentuated rhythm. Upon closer observation, the songs show something more than a feeling for rhythm; they reveal a time-sense or metrical sense. As this is an important point, permit me, at the risk of being a little technical, to call your attention to the distinction between rhythm and time-sense, or, as the Germans denote the latter, "Takt." "There is rhythm in nearly all the continuous natural sounds we hear," says Dr. Richard Wallaschek, who has written very clearly on this point; but when, for instance, we are listening to regular beats, we divide those beats in our mind according to the attitude of our observation. We group them into twos or threes, lengthen or shorten the periods or "bars." This time- or metrical-sense, this power of group perception, is not, as the psychologists tell us, "a sensation proper, as hearing, seeing, etc., but a mental work of grouping the sensations; and this takes place not in the senses themselves, but in the cortex." Dr. Wallaschek refers the origin of music to this time-sense; because, out of this sense, has been evolved the choral, or chorus,—"the germ," as he says, "which has alone been capable of enormous development in music." . . . "if two or several people sing together, then song is something more than *merely* the outcome of feeling, for they have to keep their performance in accordance with each other; and to accomplish this they have to observe, to group, to arrange the tones." . . . "They could not keep together if they did not mark periods (groups), for there is no concert possible without bars. What they perform is rhythm. What

they think is 'Takt.'" He adds, "the bird's song has rhythm, but the bird has no 'Takt'." . . . "Music requires a degree of observation, an intention, and a participation of the intellect, and not *only* a momentary vocal reflex of feeling; it requires the form of time-ordered perception, which is lacking in the animal, and so strongly pronounced in the choral, dance music of primitive men. . . . singing in concert requires a definite purpose, a definite arrangement of utterances, which are intentionally marked out, practised, and preserved in memory."

Indian songs are sung in unison; they are, therefore, products of this metrical-sense, and not merely an ebullition of a passing feeling or excitation.

Let us briefly examine the structure of these songs, and see how the untaught, unlettered Indian has arranged these tones, these music utterances, in his songs.

In the Monograph on Omaha Indian Songs, I have spoken of the preference of the Indian for the presentation of his songs upon an instrument like the piano or organ, with harmonization, that is, having chords added as a support to the aria, and I have detailed how this interesting discovery of his preference was made. The songs are therefore printed with a simple harmony, each song having been subjected over and over again to Indian criticism and correction, until it was declared by him to "sound natural," when rendered on an instrument. In this matter I deemed him to be the best judge of his own music, and I therefore set aside my own notions as to literal correctness (the Indians sing in unison and not in concerted parts), being sure I should commit a grave error if I ignored his preference and judgment of the transcription. These songs are therefore presented according to the Indian's approval of correctness. An examination of this arrangement of the songs shows that many of them embody in successive notes the chords that in the harmonization are struck simultaneously on the instrument; indicating that these chords are fundamental in the structure of the song, and suggesting that the Indian is, so to speak, unconsciously conscious of them; that the chords are in some way present to him when he sings in succession their component notes, the only way harmonization could be attempted by the voice alone.

Professor Fillmore and I have carefully studied hundreds of songs. With this fact in mind, we have examined not merely the songs of one tribe of Indians, but of widely scattered tribes; and at the Columbian Exposition we extended our observation to other races and peoples, and we have found that folk-song is universally built along the lines or tones of a chord; and that "this line forms for musical expression the line of least resistance." Professor Fillmore's study of Navajo songs has shown that, in those exceedingly primitive songs, some of which seem to be like mere shoutings, when the tone varies, it varies by rising or falling along the line of the tonic chord. This chord is made up of the two strongest upper or over tones of a single tone. You will recall that the first overtone to catch the ear is the 5th; the second, the 3d.

Now it is of interest in this connection that the Indian, in singing, al-

ways strikes the 5th with more accuracy of intonation than the 3rd. His liability to fall from pitch on the 3d often makes it difficult, particularly in solo singing, to be quite sure whether he is singing a major or a minor 3d. His execution is uncertain but not so his intention, his ideal; for, if he means to sing a major 3d, and you should play the chord of the minor 3rd upon the instrument, he would at once tell you you were wrong, that was not what he was singing. The longer you worked with him, the more convinced you would be that he had a definite ideal of his song, though he might fall short of it in his execution. It has also been noted that the more closely related tones of a chord are those which the Indian sings with the greatest accuracy of pitch; he wavers most where the natural harmonies are less closely allied.

Two points have been clearly demonstrated by this study of Indian songs, conducted by Professor Fillmore and myself. First, as he puts it: "An harmonic sense, though latent, must be inferred as existing in most primitive melodies;" and, second, "that the tonic chord constitutes the basis of tonality even in primitive music."

Dr. Walleschek, in writing on the Monograph on Omaha Indian Songs, says: "I do not share the not unfrequent opinion that a sense of melody arose at first by itself, and that to this, later on, a sense of harmony was added; for I do not think one can appreciate melody, as melody, if one has not even some slight harmonic sense. The tones would, so to speak, diverge instead of forming a connected group."

To quote Professor Fillmore's perspicuous statement of the outcome of this investigation which has now been accepted by many of the best scholars at home and abroad: "The harmonic sense is, consequently, the guiding force which determines the direction taken by the voice when it is set going by the rhythmic impulse."

We have here, if I have made myself clear, the mechanism of song-making revealed to us.

One more point of interest: These simple melodies show that the forms of musical composition which are taught in our schools of music are in accord with the forms revealed in these songs, and which we must class as natural musical utterances. In each of these songs we find a motive, a short melodic phrase, which is repeated in modified form, and that these phrases are correlated into clauses, and the clauses into periods. The difference between these Indian songs and one of our works of musical art lies in development rather than origination; within their limits they are artistic productions.

NOTE.—In October, 1895, graphophone records were taken of Omaha songs that I had transcribed fourteen years ago, from the singing of other Indians of the tribe. Upon comparing these records with the published form in the Monograph already referred to, I do not find the variation of a note, proving that no change has taken place in these songs during fourteen years. As this goes to press, I have secured from an old Ponka Indian graphophone records of these same songs as they are sung in the Ponka Tribe, he having learned them in his youth. A comparison of the records shows no material change; in two instances there is the addition of one beat in the Ponka rendition.

DWARF SURVIVALS, AND TRADITIONS AS TO PYGMY RACES. By R. G. HALIBURTON.

WHEN it became clear in 1890, that the range of African dwarfs reached as far north as the Great Atlas, I naturally inferred that in prehistoric times their range extended even far to the north of the Straits of Gibraltar. That the Atlas dwarfs had *Klicks* in their speech, similar to those of the Bushman, was subsequently established, the people of Southern Morocco, among whom they are in vogue, calling them "eating words," a term applied in Spain to a peculiarity in the speech of Andalucians.

Folk-lore has also preserved in Northern Europe distinct traditions of an early race of dwarfs, who were magicians and cunning artificers in the bronze and later ages. "Balor of the Blows," the Vulcan of the Irish, "appeared at the forge as a red-headed little boy." The Dactyls (the "Tom Thumbs" of Crete) worked at their magic forges in the caves of Mount Ida. Little dark-complexioned smiths, and magicians are still remembered in Scotch folk-lore, as "the Brownies;" and the Welsh believe in Merlin's band of dwarf smiths, who are still to be heard busily at work, making and mending armor and weapons. *Taata*, a Berber name for dwarfs, reminds us of those dwarf magicians, the Tuatha de Danann.

It seemed most likely that there must be thousands of survivals in Europe of a small prehistoric race, and that there must be references to such survivals in periodical literature, or the publications of scientific societies. A very laborious search for days in the Parliamentary Library at Ottawa was rewarded in July, 1892, by my finding in a back number of *Kosmos* (May, 1887) a paragraph of only a few lines, entitled "The Pigmies of the Val de Ribas," mentioning a paper by Professor Miguel Morayta on a dwarf community in the Val de Ribas, in the province of Gerona, Spain. They were described as having red hair, Mongolian eyes, broad, flat noses, wide, flat faces, and prominent lips; but the paragraph neither stated where the paper had appeared, nor gave the author's address. Unfortunately the editor of *Kosmos* was dead, and *Kosmos* itself had come to an end. Dr. Leitner did his best to assist me, and wrote, but without success, to a scientific man at Barcelona. The British Minister in Spain also had an inquiry made at Madrid, but no one knew of these dwarfs, or of the paper, or its author. Later on, I found a half-breed Spanish Nana woman who had decided *klicks*, which she said she had inherited from *Nano* ancestors. She gave much interesting information about the Nanos, many of whom resided in the mountains of Murcia. Although a large woman herself, her daughter and her grandchildren were all dwarfs,—some of them not exceeding four feet in height.

Early in May, 1894, Mr. MacRitchie visited the Val de Ribas in order to verify the statement of Mr. MacPherson, lately British Consul at Barcelona, that there were racial dwarfs in the Eastern Pyrenees; and simultaneously I received from Mr. MacPherson a copy in Spanish of the long-sought-for paper of Professor Morayta, which, however, did not state

whether it had been published or not. The gist of the Professor's paper, therefore, will be read with interest.[1]

These people (he says) live among a larger population of ordinary Catalans, who have resided there from a remote time, and who regard the dwarfs as a distinct race, calling them *extranys* (foreigners), and also *fenomenus*, and look down upon them as laughing-stocks. A good many of them, he says, suffer from *paperas* (goitre), which is phenomenal in some, and is called *Goll*, and the persons affected are called *Golluts*.

A medical man who has attended such cases tells him that these golls can be successfully treated by iodine.

The idea that arsenical waters cause the Nanos to become Cretins and dwarfs is refuted by the fact, that their Catalan neighbors do not suffer thus. In early youth Cretinism does not appear, but on their reaching maturity the *golls* begin to show themselves, increasing with years to the size of a small melon. "If all these Nanos had *golls*, I should infer that the *goll* was the cause of their low size and of their limited intellectual development." He thinks that those of the Nanos who have poor and scanty food die out. He adds all this "shows that the *Nanus*[2] are a peculiar race, with all the characteristics of such." Some of these people who live comfortably are intelligent enough to carry on business successfully. "These and many other instances show that their stupidity is the result of the way they live. . . . It may turn out that the existence of this race at Ribas may end in showing that in *very remote ages there existed in Europe a Tartar race, which hitherto has not been discovered.*"

Professor Morayta's paper shows that Cretinism is *racial;* but he does not explain very clearly the cause. That a dwarf Turanian population once existed throughout Asia and Europe we can hardly doubt, though survivals are only to be found in the recesses of mountains. All over the world dwarfs are born hunters, and therefore flesh-eaters. When their game is destroyed, or they are driven from their hunting grounds, they, no doubt, lose their wonderful strength and agility, and gradually becoming moribund, go through the long process of dying out, just as many plants have died out when the soil or the air no longer supplied them with the necessary nutrition.

Those who suppose that Cretinism is the cause of dwarfism and of the peculiarities in looks, color, etc., of the dwarfs of the Pyrenees and the Alps, are mistaking the effect for the cause, and are "putting the cart before the horse." In my paper on dwarf survivals, read at the Association last year, I suggested that Cretinism was not a disease, but a symptom of decadence among a racial dwarf population. I have met with a singular confirmation of this view. Last spring I visited some Acadian districts in Louisiana, and learned that in the old French spoken there *Cretin* simply means a "stupid dwarf," and has no reference in any way

[1] As much of this paper was written for publication in an English periodical a year ago, some of my quotations from Professor Morayta's paper are the same as those that appeared in my paper of 1894, "Survivals of Dwarf Races in the New World."

[2] This ending in *u* is probably Catalan. In Spanish a male dwarf is a *Nano*, and a female *Nana*. The people call themselves *Nanos*, not Enanos.

to any disease. No doubt goitre, being especially prevalent among the dwarf populations of the Pyrenees and the Alps, was called "the dwarf disease," Cretinism.

The Denga dwarfs are the same now as they were five thousand years ago, yet we do not hear of goitre among the robust and warlike pygmies of the Great Lakes and the Congo, who are flesh-eaters and hunters. I am persuaded that if a child of a Pyrenean Cretin were to be fed on flesh food, and made to lead an active life, he would never show any trace of goitre on arriving at manhood. May not "Cretin" be a very ancient name for a dwarf? The little Dactyls, as we have seen, were *Cretans*.

The Professor describes the stature of the Nanos as "about 4 ft., or one metre, 10 or 15 centimetres. The Nanu is well formed; his foot is very small and well shaped; and so is his hand, but its palm is much developed, whence the fingers seem shorter and fatter than they really are. They are very broad-cheeked, which makes them seem stronger than is actually the case. They look like small men. In general they all walk inclined forward." This peculiarity appears also in the Ainos, and is ridiculed in the Japanese illustrations of Mr. MacRitchie's work. Professor Huxley, in describing "Iberian man" of glacial eras, states that he must have walked thus, a conjecture which, even if nothing more than a lucky guess, is interesting.

The men and women have a well-shaped calf and leg. Their features are so characteristic that to see one of them is to see all. Their hair, he describes as red, "like that of a peasant who does not comb or take care of his hair." "They have a round face that is as wide as it is long; the cheek bones are very prominent, and the jaw bones strongly developed, which makes them look square. To this square look the nose contributes. It is flat and even with the face, which makes it look like a small ball, and the nostrils are rather high up. The eyes are not horizontal, the inside being lower than the outside, and they look like the Chinese, or rather like the Tartar race."

I lent Mr. MacRitchie a photograph which I had had taken of a half-breed Murcian Nana, with her granddaughter. The people of the coast town in Morocco, where she now lives, all noticed her Chinese look. Mr. MacRitchie has just returned the photograph, and writes that a person, not interested in dwarfs in any way, remarked, on looking at it, that he would take it for a likeness of a Chinese woman.

Professor Morayta says that the Nanos have only half a dozen straggling hairs on their face, which is discolored and flaccid to such an extent that it seems to have no nerves. Hence, even when they are very young, they have many wrinkles. "In short, they have the face of an old woman. If the Nanos all dressed alike it would be difficult to tell the men from the women. Their odd look is increased by their large mouth, which does not cover their long and strong teeth. Their incisors are remarkably long and strong, and their lips are always wet with saliva, as if from water-brash. The brutalized life they lead may explain their being so ignorant that many of them do not remember the name of their father or of the place where they live."

In 1894 a dwarf about four feet high, a native of Darfur, who has for years been living in Cairo, was brought to me. He resembled, in many respects, the dwarfs of the Pyrenees. He had the same large teeth, open lips, and excessive saliva, but his walk was a roll from side to side. I did not notice his bending forward. His walk was precisely like that of *Gitano-Nanos*, which the old Murcian woman described and imitated. His color was a reddish brown. At the Hotel Métropole, Cairo, there was another, but somewhat different dwarf, from the upper Nile region, who was quite black, and had thicker lips. I did not notice anything peculiar in his walk. The natives of the Atlas say that there are black dwarfs there who are larger than the other dwarfs. Zebehr Pasha told me in 1893 that the dwarfs of the upper Nile region are called *Denga*, and are greatly superior to their larger neighbors in intelligence. On the monuments two *Denga* or *Deng* dwarfs are described as having been brought to Egypt, who "danced divinely," and were more prized by the Pharaohs than the products of Pount. One is described as from the Holy Land of Pount, and the other from "the Land of the Blessed Spirits," probably another name for Pount. Maspero, in his Origin of Civilization (1894), calls these dwarfs *Danka*, but the Report of the Egyptian Exploration Fund, October, 1894, calls them *Denka*, or *Denk*. One of the names of the dwarfs of the Atlas is Ait Tinker, or Dinka. In my paper on "Prehistoric Star-Lore" full reference is made to Denga dwarfs.

Mr. MacPherson, late British Consul at Barcelona, who kindly made enquiries into the statements of Professor Morayta, fully confirmed them. He said that small-pox carried off hundreds of these Nanos a few years ago, and that they are rapidly dying out, and he thinks that more of them are to be found at the Col de Tosas than anywhere else. He was satisfied that there are many Nanos who are Cretins, and many who are not. Mr. MacRitchie spent a few days in that country, but the weather and the roads were very bad, and prevented his remaining there longer. There is also a village called Aledo on the summit of a high mountain between Carthagena and Granada, "inhabited by small people," which I wished him to visit, but he was unable to do so. Many weeks, or rather months, would be required to explore thoroughly the regions where it is said the Nanos are to be found. The British Vice-Consul at Carthagena intended to visit Aledo in 1893, but I have no tidings yet of his having made the excursion. We must hope that he will yet visit that place. Mr. MacRitchie has published an interesting paper on these Pyrenean dwarfs, in the "Internationales Archiv für Ethnographie," Leyden, in which some kodak photos of those dwarfs have been given by him.

Since my paper on "Survivals of Dwarf Races in the New World" was read at the meeting of this Association at Brooklyn, many things have come to light fully confirming my conclusions. In "The Academy" (London), Jan. 12, 1895, Mr. MacRitchie says, "Captain Foxe, in 1861, discovered an island cemetery in the northwest corner of Hudson Bay, in which the longest corpses were not over four feet long. Whereupon Foxe says, 'They seem to be a people of small stature. God send me better for my adventure.'" He has also drawn my attention to a list of the Indian

tribes of the Valley of the Amazon, by Clement R. Markham, recently published by the Anthropological Institute of Great Britain and Ireland, which mentions two dwarf tribes there, the Guayazis and the Cauanas, citing as his authorities, Acunã, Castelnau, Spix and Martius, and others. But for the most important confirmation we are indebted to the ubiquitous press correspondent. Writing from the city of Mexico to the Chicago Tribune, Oct. 15, 1894, its correspondent, describing the various races to be seen in the streets of the city, includes "Indians from the hills, and queer little dwarfish savages, clad in two coarse woollen garments, who have their Hottentot-like habitations within the gates of the city, living in their huts of adobe, in settlements often found behind respectable blocks of houses, ... those strange dwarf people, who glide in and out of the crowd like gnomes."

A casual authority of this sort, who only describes what he sees, and does not trouble himself about scientific theories, is really more conclusive than the observations of a specialist, however candid he may be as to his favorite study. The testimony of this correspondent has been borne out by Mr. Robert Clarke, the Cincinnati publisher, who informs me that he also has seen these dwarfs. Mr. H. V. Wills, of Boston, Mass., tells me that his attention was attracted, at a representation of a Passion play near the city of Mexico, by some very small Indians, whom he "at first took to be overgrown children. They looked more like squaws than men, and their faces were broad, flat, puffy and wrinkled."

This is the description that M. Charnay gives of the Lacondon, on the frontier of British Honduras. He does not describe their height, but says that he could not tell the men from the women, and that they had broad, flaccid, puffy faces—almost the very same words as those used by Professor Morayta as to the Nanos of the Pyrenees. Mr. A. Glaspell, an American who has had business engagements in Mexico, says that on the 12th of December, the fiesta of our Lady of Guadaloupe (the old feast of "the Mother of the Gods"), he saw many dwarfs, who were not much over four feet in height, and who had come in from the country.

Another important confirmation by a press correspondent is that unconsciously supplied by one who interviewed, at Cincinnati, last autumn, the German Dwarf Operatic Company, and who stated that he had found that these Liliputians all came from a district in the Black Forest, and were *racial* dwarfs, and not mere accidents or freaks of nature. Professor Edwards, of the Cincinnati University, drew my attention to this subject, as to which, no doubt, further information will come to light.[1]

I was fully prepared for some such discovery. Thirteen years ago my attention was attracted by the name of some cliff dwellers in Abyssinia, which Jéan Temporal, in his translation of an early Portuguese book on that country, calls "Vosges." As I had in 1863 suggested[2] that there

[1] A German tells me he has often seen dwarfs about four feet high, who came to Baden from the Black Forest.

[2] See Haliburton, New Materials for the History of man (1863), pp. 14, 23 and note, 41. 74.

must have been a migration from Africa to Europe in early ages, I made a note of these facts, intending some day to enquire whether there are not traces of cliff dwellings, or cliff dwellers, in the mountainous country of Alsace, "the Vosges." In 1892, as my friends, Admiral Blomfield Pasha, of Alexandria, and Mrs. Blomfield, were about to spend six weeks in the Vosges, I asked them to look into the question. In a few weeks I received a local guide-book, which more than bore out my anticipations. In the *Guide Joanne*, Géradmer (Paris, Libr. Hachette & Cie, p. 26), we are told that La Schaume of Nisheim, which surrounds Wurtzelstein, it is believed, is inhabited by a kindly disposed race of dwarfs, who, when the herdsmen descend to the lower valleys with their herds in the autumn, pasture their cattle, which are of very small size, in the upper pastures, and make cheese till the spring. Among different authorities cited is the *Foyer Alsacien*, by Chas. Grad. Admiral Blomfield Pasha wrote me that a very intelligent fellow-traveller, a Frenchman, believed that there were many racial dwarfs in that part of Europe, and that a careful search would put this beyond question. I also made enquiries as to the "dwarfs of Sylt," which it is supposed were exterminated by the Frisians. My informant got for me the following information from the head of the Archæological Institute of Kiel: "The people call traditionary dwarfs *Die Unterirdeschen*, *Alben*, *Wichte*, *die Kleine Leute*, [the Underground People, the Albs, the Wights, the Little People], and there is no end of Sagas telling about them. Our country and Sylt are full of them, and I heard some quite new to me on this occasion. They have been digging lately in several places for skeletons, and the villagers said, 'Yonder, under that village, the Little People used to live;' and in another village the people said that under a certain mount five sets of the 'Underground Folk' lived, but they only had one cauldron (caaldron) between them, and when one party was invited by the other the cauldron had to be taken for cooking. The mount was opened, and a huge cauldron was found. Now you hear of kind acts done by these little men, and again of wicked, revengeful, spiteful deeds."

Fifty years ago that intellectual giant, Jacob Grimm, was far in advance of scientific men of our day as to this question. He seems to have assumed that there was once a widely diffused dwarf population in northern Europe, and he gives in his German Mythology an immense amount of references and traditions as to dwarfs, as will be partially seen on referring to the index of that work.

In 1892-3, Professor Sergi published in the Bulletin of the Royal Medical Academy of Rome an important paper, showing that in early ages there must have been a migration of African dwarfs to the European countries bounding on the Mediterranean, and as far east at least as Moscow. He has made a comparison of the numerous dwarfs he met with in Sicily and Italy with skeletons of dwarfs found in Etruscan tombs and near Moscow—all resembling the dwarfs of the Congo.

There are really only two classes of dwarfs, one stunted and deformed in infancy through disease, and the other *racial dwarfs*, for we may safely

put down to *atavism* cases of the Tom Thumb type hitherto looked on as "freaks of nature." Sir Geo. Humphrey, M.D., found in all the museums in France only one skeleton of a supposed dwarf "freak;" and even that, we find, was nearly a century old, and belonged to a member of a family in the Vosges, in which there were other dwarfs. (See my paper on dwarfs, in Asiatic Quarterly, July, 1892.) I find I have omitted to mention that in 1893 (*i. e.*, after I had heard from Blomfield Pasha), I learned in Morocco that, two days south of the Great Atlas, there is a high mountain called *Voshe*, the inhabitants of which are dwarf cave-dwellers, who are called Ait Voshe (the Voshe Tribe). We have seen that Jéan Temporal called a cave-dwelling tribe of Abyssinians "Vosges;" and Professor Schlichter says that the Akka dwarfs of Equatorial Africa are known to their neighbors as *Voshu*, and also *Tiki-Tiki* names connected with the Akka dwarfs of Southern Morocco, who are also called Jed-ibwa (the "Fathers of Our Fathers"). When I asked natives of Southern Morocco, "Have you ever heard of the name *Tiki?*" I carefully avoided using the reduplication. They all said "Yes, Tiki-Tiki, Tiiki-Tiiki; that is a name for the Little People;" and subsequently a half-breed Spanish Nano gave me the same reply. The range of *Tiki-Tiki* extends to Polynesia, where it is used for ancestral dwarf-gods, one of which, the dwarf Creator, Tiki, resembles the dwarf Creator, Ptah, of the Egyptians.[1] "Tiki" and "Tiiki," seem to be a shortening of those names for dwarfs and dwarf-gods, so familiar to the ancients, and still used in Morocco—*Patiki*, and *Patäiki*. The Tiika-Tiika (a name not hitherto known to anthropologists) are very small dwarfs in South Africa, who, the Kaffirs say, are a perfectly distinct race from the Bushmen. Through his tutor, Dinuzulu informed me that the Zulus have killed them nearly all off, as "they are not fit to live." The Kaffirs greatly dread them as most dangerous wizards and magicians.

Atavism is very enduring and far-reaching; and generations, or rather centuries, are not able to efface the traces of racial, or even family traits, as can be seen in family portraits. The leading family in a district in Andalucia were surprised and shocked at finding one of their number grow up, in all respects, a typical Congo dwarf. No doubt they had inherited a remote Nano strain, which, though long forgotten, had at last asserted itself.

Size, complexion, etc., point out the places where a dwarf race must have once existed. The Black Forest is probably one of these, for the manager of the German Dwarf Operatic Company says he was able there to secure the services of several very small dwarfs. Their relatives were generally of large stature. In Sicily, and parts of Italy, Professor Sergi

[1] *Tiki* we can trace even to Peru, where, according to Santa Cruz (see Markham's Narrative of the Rites and Laws of the Yncas pp. 83, 84 and plate, and 98), the Supreme God, "the Creator," was called *Ticci* Ccapac (sometimes softened into *Tiçi* Ccapac), and *Tica* Ccapac, and was represented by an egg shaped symbol. He was born of a Condor's egg, and was, no doubt the same as the primordial dwarf God of the Mayas, whose temple at Uxmal was "the House of the Dwarf," and who was born of an egg (see pp. 124, 125, 135 and 142).

discovered and measured a surprisingly large number of dwarfs, many of which were as small as Congo dwarfs.

The name, "Little Father," for the dwarfs of the Atlas, and sometimes in Spain for the Nanos, must have drifted as far east as Moscow, when that prehistoric migration of African dwarfs took place, of which Professor Sergi has told us, for it still survives in that strange title by which the Czar is often addressed—*Little Father.*

I may mention a fact that has been long known to me, that the names "Dwarf" and "Fairy" came originally from North Africa, where they are still in use. Ancient Greek geographers say that the farthest west part of Gætulia (southern Morocco) is inhabited by the Maurussii and Pharussii (*Mauri* and *Phari*).

I have been frequently told by Berbers that *Fari* was a name for mining dwarfs, who wash gold and silver sand. I did not notice any superstitious dread among the Berbers as to using the name, but among the Spanish half-breed Nanos it seems to excite the same horror that it does among the Irish, Welsh and Highland peasants. My Murcian informant nearly rushed from the room at the sound of the name, and begged of me never to use it again. It is evidently an "unpronounceable name." This may be a superstition connected with the belief that if you can get hold of the name of an enemy who is a magician, you can destroy his power over you. A Highlander was able once to capture a fairy wife by finding out her name. The Irish peasants will speak of "the good people," "the gentle folk," or "the gentry," or "the little people," but you cannot get them to use the word "fairy."

The name "*dwarf,*" too, is Berber. There is a town or hamlet in the Sahara, some days to the southeast of Tafilet, called *Adwarfi* (a corruption of Ait-Warfi, "the good people," "the excellent folk"), and the place is a great centre of the little *Adwarfi.* (*Razel warfi* means "a fine man.") In Spain the Nanos are called *Adwarfi.* But the old Murcian woman used the name unwillingly. Many names and subjects among the Nanos are sacred or "tabooed." She told me she knew much about the *Cabrillas* (or "the kids")—the Pleiades; but it was not lawful to speak about those stars.

Both in Scotland and southern Morocco we meet with artificial mounds, in which there are chambers. In Southern Morocco they are inhabited by dwarfs, who take into them at night their little cattle. One of my informants, a Berber Jew, told me that, when a boy, he ventured once to sleep in one of them; but that the Berbers generally are afraid to enter the small, dark passages that lead to the central chamber; and call the little entrances "rat holes."

The name *Pecht,* which is used in Scotland for a dwarf, and is more familiar to us as "Pict," is to be found south of the Atlas. A "Large Haratin" (a native of the Dra, who is descended from dwarfs) told me that he belonged to the Ait-Pecht. His dwarf klicks made the name sound like *Psecht.* On one occasion, without having been questioned on the point, my Spanish informant gave me an account of the dwelling places of the

Nanos of Aledo, which she said were built of large stones, covered with earth, and which were evidently similar to those of the Adwarfi and to the Picts-Houses of Scotland.

The head of a branch of my family for centuries went by the name of Pitcur, from owning Pitcur Castle, in Forfarshire, Scotland, now a ruin. Mr. MacRitchie, at my request, visited a place near the Castle, in which, I heard, there was a small passageway leading into a hill, for I fancied it must be a *Pict-cur*, a dwelling place or enclosure of dwarfs. The idea proved to have been well founded, and he wrote to me, that it was one of the best specimens of a Picts-House that he had ever seen. He afterwards learned that he was not the first antiquary who had explored it. If there is any foundation for the wonderful legends, that tell of the oldest castles in the North Country having been built by dwarf masons, Pitcur Castle must have been their handiwork.

Professor Sayce, in his note to Herodotus (B. III, Ch. 37), connects the name of "the Creator" of the Egyptians, *Ptah*, with that of the *Pataïki*. The philological argument is confirmed by the fact, that both Ptah and the Pataïki were dwarfs. Not only in Egypt, but also in Greece, the oldest of the gods were pygmies. Venus of Cyprus was a dwarf; her son was *Pygmæus*, and her husband, Vulcan, was no doubt a Dactyl, one of the dwarfsmiths and magicians of Crete. Selden says that the Great Gods of Palestine and Syria were pygmy deities (Pataïki).

Movers, in the first chapter of his Phoenizier, says, that "that group of deities called Dactyls, Corybantes and Cyclopes, were similar to those old Germanic divinities, now known as "Cobbolds." I had not seen that passage when I suggested in my paper on "Dwarfs and Dwarf worship," that they were "like our Fairies and Brownies."

The name, *Pataïki*, is still to be heard. In parts of North Africa, and probably in Syria, the Jews hold a festival towards the end of April, called "the Great Play," and also *Pataïki!* When I asked an old Syrian Jew who lives in Alexandria, Egypt, what was the meaning of the name Pataïki, he replied, "*Kabir* is God; *Kabirieim* means the large angels, and *Pataïki* the little angels." Pausanias identifies the Pataïki with the Cabiri. But the oldest sources of religious thought among the ancients were the Mysteries, and these, it is admitted, all sprang from the venerable Mysteries of the Cabiri, *i. e.*, from dwarf mysteries.

Grimm, in his German Mythology,[1] shows how widespread was the belief that the first created race were dwarfs. Hesiod says the first race of men died out, and became blessed spirits, who were the guardians of mankind. In the West Indies[2] there was a very similar belief. The mothers of the first generation all fell in love with a primeval Lothario, and deserted their children, who grew up stunted, and ultimately died, and became *Tona* (guardian spirits), and were worshipped by men.

Among the Zuni and other Pueblo Indians, the first generation of men are called "child ancestors" (their name being written variously, Koko,

[1] See Staleybrass' Trans. II, 563-9.

[2] Kerr's Voyages and Travels, III, 134.

Koka, or Kaw-kaw). They are intercessors for rain, and initiate youths, and take an important part in certain rites. They are represented as dwarfs, and are evidently liable to hunger, judging from the amount of provisions with which they have to be supplied when they visit their descendants. Among the Klamath Indians there is a belief, that there are certain dwarfs whose little footprints can be seen in the snows of the Cascade Mountains, but who are only visible to the medicine men whom they instruct in the mysteries of the Medicine-lodge. The Micmacs have a very similar belief in little men who live in the woods, and who, if conciliated successfully by a Micmac, will give him magic lore. Among the Choctaws there was a belief that little "Men of the Woods" catch the young men and, after putting them through an ordeal of good natured teasing, initiate them. *Bopuli*, a mischief-loving Robin Goodfellow, is the *Kokopuli* of the Pueblo Indians.

Mr. J. A. Watkins of New Orleans, an old gentleman, whose father lived among the Choctaws, and who when a boy learned their language, writes me that in the first half of the century a deputation of Choctaw chiefs waited on the government agent, and begged him, as they were fearing the effects of a drought, to let his two sons, young boys from eight to ten, visit them and bless their crops. Willing to humor them, he let his sons go. When they had been taught the proper rites they went through the ceremony so well that a heavy shower fell next day, and they returned home loaded with presents. Dwarfs could no longer be procured to pray for rain, and the nearest approach to a dwarf was a young boy!

Others practise this pious fraud. Our little May Queen, and the Lord of Misrule of mediæval festivities were no doubt once dwarfs. At the beginning of May, the Japanese have a little King and Queen, who are to be seen also at St. Michael in the Azores, where at Whitsuntide, amid an immense crowd of spectators, a little King and Queen are carried in state to the Cathedral, where they are in great pomp crowned by the clergy. A procession then takes place to some tables at the market-place, where they preside over the feast, in which the poor participate. In China a little girl receives the offerings to the dead. In India[1] Durga, or Kali, is represented by a little girl who sits in a "bower of leaves." In a similar bower a little child-wife in the Western Soudan receives the god *Sokar*, no doubt the same as the ancient dwarf god of the Egyptians, Ptah-Sokar-Osiris. In Egypt[2] there was a great feast at Pithom at the beginning of May, at which two little girls officiated, who were called *Urti* ("the two Queens"). Possibly they may have been two little brides for Anuk, who is so venerable a divinity, that he may be only another type of the dwarf god, Ptah-Sokar-Osiris. In the Tonga Islands Alo-Alo, the god of rain, when he visited the earth, was welcomed by a little child-wife, who presided during the festival in a leafy bower.

We find that the Atlas dwarfs and the Nanos predict the future by

[1] Sir Wm. Jones' Works, IV, 132, 185.

[2] Brugsch, "Egypt under the Pharaohs," II, 347.

watching the reflection of "the Seven Stars" in a bowl. The famous cup of Nestor, supposed to have been a divining cup, had two groups of Pleiades on its handles. In modern Egypt the person who tries divination by a bowl, is always a boy. The Atlas dwarfs, who "know more about the stars than other men," drive a good business in the Balaam line, by blessing (if not by cursing). A little Ait Atta, from near Adwarfi, who was stolen from his parents and sold as a slave, but ran away and found his way to Tangier, told me in 1894 that the Little People are greatly feared by his tribe, who address a dwarf as *Sidi Baraker* ("our Blessed Lord"). "When we see them coming, we lay down our presents before us, and bow down; and they put their hands on our heads, and bless us and our crops, and take our presents, and go away."

The Bushmen claim that their primordial mothers were the Pleiades, a star group which the ancients regarded as "Royal Stars." According to Grimm, dwarfs were supposed to be "of Royal birth." Wherever we find dwarf tribes, or their descendants, there we find vestiges of the Year of the Pleiades and of a worship of those stars.

I cannot go further into this curious subject; but I may, in conclusion, suggest that there is a marvellous and puzzling uniformity in the ideas of primitive races as to festivals, magic, healing by incantations, etc., which can only be accounted for by assuming that, in the most remote prehistoric times, there must have existed an era, in which was developed a rude system of initiations, that diffused, preserved, and at the same time stereotyped, the scanty stock of star-lore, beliefs, and domestic arts of those early days.

NOTE.—Prof. Frederick Starr, Dept. of Anthropology, Univ. of Chicago, Translator of *Les Pygmées* by de Quatrefages, on his return from Mexico, in a letter dated 26 Sept., '95, writes me as follows:—

"Aguas Calientes is a city of perhaps 30,000 inhabitants. In a single half-hour in the market we saw seven adults who were not more than four feet high. Of one of these we have a photograph which I shall be glad to send you presently. The people of Mexico generally are small. There is an unusual amount of difference between the males and females in stature. The women therefore are generally small. But the cases mentioned above were far below the ordinary stature. The little people you mention, quoting from the Tribune Reporter, are certainly from *Aytzcaputzalco*, which is connected with the City of Mexico by St. Care. They are very small, retain their old dress, are reserved and very primitive. I am told that many of them live in holes in the soft tepetate rock. These are special topics which I shall study hereafter. I have Indian authority for dwarf populations near Lake Chapala in Western Mexico. . . Several Indians at Chapala tell me that there was a fiesta there nine years ago which was very well attended. Among the people were about twenty little people, representing a dwarf race living in the mountains. They are described as about a yard high. All wore knives, and were very fiery tempered. They stood no teasing from the people of the region.

I noticed an unusual amount of little people going from Puebla to their homes. We saw a hundred perhaps go from market past us, as we sat at a bridge. The little stature was marked in both sexes and most so in the women. Many adults could not have been more than thirty-five to thirty-eight inches high. . . . These little people probably came from Cholula, or near there. Most of them were primitively dressed. This I find commonly among the little people. They are conservative and reserved.

Critinism occurs in the Barranca near Guadalajara. I have not looked into it. A dwarf population, the Chontales, are reported to me by Archbishop Gillar of Oajaca.

They live far from him, and he has never seen them. They are said to live in holes in the ground." Writing about *the Little God*, at Lake Chapala, he says: "There are found, in the bed of the lake, very many curious little vessels of clay and, strange to say, spoons and ladles of the same material." The school-master there said: "The people that used to live here, unlike their neighbors, had a God who was little; therefore the gifts that were made to him were little."

That once there was a numerous dwarf population throughout Mexico, is proved, he thinks, by the small size of the Mexicans.

PREHISTORIC STAR-LORE AND ITS PLEIADES PERIODS. By R. G. HALIBURTON.

[ABSTRACT.]

THE great games and secular feasts of the Greeks, with their funereal characteristics, their "Pythian eight year cycle," and their "Olympiad," or four years cycle, are found reproduced in the secular funeral games, regulated by the eight and the four years Pleiades periods of American races.

Among other authorities cited were the Journal of American Folklore, April–July, 1895, pp. 162–165; Dr. Fewkes "A New-fire Ceremony of the Tusayan Indians;" Müller's Dorians (Tufnell & Lewis' Trans.), Vol. I, 310, 311, 348; also 159, 296.

The writer suggests that the dawn of astronomy was preceded by what he has defined as "Prehistoric Star-Lore."

ACCOUNT OF THE DISCOVERY OF A CHIPPED CHERT IMPLEMENT IN UNDISTURBED GLACIAL GRAVEL NEAR STEUBENVILLE, OHIO. By Prof. G. FREDERICK WRIGHT, Oberlin, Ohio.

[ABSTRACT.]

THIS paper contains detailed evidence of the discovery of a chipped flint implement in the glacial gravel terrace on the Ohio River near Steubenville, Ohio, making the third locality in the State in which the existence of glacial man is proven by specific satisfactory evidence. The discovery was made in the summer of 1893 by Mr. Sam Huston, the county surveyor of Jefferson County, a well-known, highly educated, and honorable man, residing at Steubenville, and one whose familiarity with gravel deposits and the indications of their being disturbed or undisturbed is unexcelled by any one in the country. For a long time the railroad has been engaged in removing gravel from pits along the extensive glacial terrace below Brilliaht Station, on the Cleveland & Pittsburg R. R., about seven miles south of Steubenville. While excavations were in progress two years ago, Mr. Huston was engaged in overseeing public work in the immediate vicinity. When work was suspended for dinner, Mr. Huston on one occasion went into the pit to eat his own luncheon, when his attention was attracted by the flat end of a flint implement slightly projecting from the perpendicular

face of the gravel which was being removed. The material at this immediate locality was well-washed sand with very few pebbles. The bedding and cross-bedding were very clearly displayed, and it was perfectly evident that there had been no disturbance of the strata since their original deposition. The situation in the face of the bank was such that Mr. Huston was barely able to reach it with his hand by standing upon the slight amount of talus that was at the bottom, and was about half way up to the top of the bank, making it about ten feet below the surface. Mr. Huston conducted me to the locality, and this evidence was collected upon the spot. The bank was subsequently worked off about twenty feet farther, but the stratification is essentially the same as is shown in photographs of a fresh section of the bank. The evidence is so specific that there is no chance to question it in detail, since every item was carefully considered at the time, and has been clearly retained in Mr. Huston's memory.

The gravel terrace at this point is one of the most extensive in this portion of the Ohio River, and is part of a series of terraces traceable from Pittsburg down to Wheeling, and indeed throughout the whole length of the river as far as Louisville. There is no question among geologists as to its glacial age. It corresponds precisely, in the Ohio River Valley, with those along the Delaware, in New Jersey, and the Tuscarawas and the Little Miami in the Ohio, where relics of glacial man have heretofore been found. These terraces along the Ohio regularly alternate from one side to the other. Below Beaver, Pa., the terrace is 125 feet above the river. The height, however, diminishes gradually as we get farther away from the glacial boundary and the supply of material contributed by streams coming from glaciated area. The terrace at Brilliant rises a little over seventy feet above the river, and extends southward for a distance of two miles, being more than a quarter of a mile wide for a considerable portion of the way. The implement was found near the lower end of this section of the terrace, and about half way between Riddle's Run and Salt Run coming in from the west. To any one who inspects the locality it will be seen to be impossible to separate the gravel strata in which this implement was found from the glacial deposit which is here so plain and so characteristic of the region.

The implement is of dark chert, one inch and three-quarters long, three-quarters of an inch wide in the broadest part, and was submitted to the Section for examination.

[The paper is published in full, with maps and illustrations, in the Popular Science Monthly for December, 1895.]

ANTHROPOMETRICAL, PSYCHO-NEURAL AND HYPNOTIC MEASUREMENTS. By ARTHUR MACDONALD, U. S. Bureau of Education, Washington, D. C.

[ABSTRACT.]

THE chief object of this paper was to describe and exhibit recent instruments of precision (some of my own construction), to explain their purpose and to illustrate the method of use.

MENTAL MEASUREMENTS IN ANTHROPOMETRY. By J. McKEEN CATTELL, Professor of Experimental Psychology, Columbia College, New York, N. Y.

[ABSTRACT.]

THE paper urges the importance of extending anthropometric measurements so as to include mental as well as physical traits, and suggests directions in which it is possible to make mental measurements. The tests made in 1894 on Freshmen entering Columbia College are described and the results communicated. These tests are partly physical (of size, weight, etc.); partly psycho-physical (of strength, eyesight, hearing, etc.); and partly mental (of memory, imagery, time of perception, etc.). In conclusion it is suggested that it would be desirable for the American Association to follow the British Association and carry out arrangements for making anthropometric measurements of members and fellows at the annual meetings.

[This paper will be printed in The Psychological Review.]

A STUDY IN ANTHROPO GEOGRAPHY TO ILLUSTRATE THE IMPORTANCE OF ANTHROPOLOGY AS A BRANCH OF SOCIOLOGICAL INVESTIGATION. By WILLIAM Z. RIPLEY, Ph.D., Asst. Prof. Sociology, Mass. Inst. of Technology, Boston, Mass., Lecturer in Anthropology, Columbia College, New York.

[ABSTRACT.]

THE influence of geology and topography in France in affecting the distribution of the ethnic elements. Effect upon the size and character of agricultural property; on the proportion of rural population of individual householders, birth rate, diseases, and other moral and vital statistics, etc., etc. Finally, the environmental and ethnic factors traced in the distribution of the various political elements by means of election returns.

Each of these illustrated by a large wall map, statistically constructed especially to show the application of the geographical method of study. Several of these maps are entirely original. The anthropological maps follow Collignon, Topinard and the best authorities.

This will be rather a report of progress than a complete study; more will be added in due time.

THE EDUCATION OF BLIND-DEAF-MUTES. By JOHN DUTTON WRIGHT, 42 West 76th St., New York City.

[ABSTRACT.]

THE education of the deaf perhaps the most difficult branch of educational science.

Extent of the work now being done not generally known.

Importance of study and investigation in this line.

Language. Speech. Lip-reading.

Difficulties immensely greater in the case of a child not only deaf but blind.

Brief résumé of the history of this work, with an account of the wonderful results obtained, and the methods employed in surmounting the difficulties.

Some of the problems still to be solved.

A STUDY IN CHILD-LIFE. By LAURA OSBORNE TALBOTT, 927 P Street, Washington, D. C.

No subject connected with the development of the mental powers seems to require more investigation at the present time, than the best method to be pursued in the education of the directive power of the will.

The whole system of education has been to submit the will power to the restraining influences of external sources of education.

May we not properly consider the advisability of developing a proper directive force along with the natural internal growth of will power.

Dr. Carpenter writes (Phys. p. 540): "The real self-formation (of the child) commences with his consciousness of the possession of that power which enables him to determine his own course of thought and action; a power which is exercised by the Will, in virtue of its domination over what may be designated as the automatic operations of the mind."

No philosophic discussion is necessary to add anything to a statement made by a writer of such judgment as Dr. Carpenter.

Neither is it necessary to array facts in order to authenticate such a statement.

The fact still remains, that society suffers from the malformation of the will power of the individual, as its deleterious effect is everywhere apparent.

An imbecile may have will, but not directive power.

A person may have an object in life, so called, and yet no directive force to accomplish that object. "To get there," is a slang phrase, but very significant, psychologically, in this connection and in this country.

Thos. A. Edison and men of such minds attain their object: the power is entirely from within; environment would make but little difference to such a will power, it knows its own power and grasps its object, and good results follow.

The great question of immeasurable importance to society to-day is how to enable the individual, with all the burdens of heredity and environment, to adapt itself properly to time, place and circumstance.

What are the best methods to be employed to give each individual a healthy consciousness of its will power, and a knowledge of how to utilize it for the best results to itself and to others, whether man or brute?

The many-sided nature of the child is like a wind instrument, sometimes evolving sweet music, and again discords, as it may be left to be played

upon by the force of its untutored will power, or by the passions of other individuals, without the conscious power of its own rightly trained directive force.

Family life constantly reveals the saddest of cases of weakness and of criminality, caused by the ignorance of guardians in giving the child a proper knowledge of its own directive power.

The Celtic race, so gifted with fine qualities of mind and heart, fails in directive power from long repression at home, but its elastic temperament rebounds under the broader civilization of America; the Celt is ever the child of impulse, and as apt to tumble into misery as into joy, just as accident may provide.

Such natures as Byron's are the sport of every wind that blows; those like Napoleon's are the victims of what he termed fate.

Macaulay writes of these two men: "It is unnecessary to make any reflections. The history of these two men carries its own moral with it. Our age has been fruitful of warnings to the eminent, and of consolations to the obscure. Napoleon died at Longwood; Byron, at Missolonghi." These words mean so much,—exile, misery, and the death not only of the body but of the objects of their life-long ambitions. They were the victims of ill-directed will power.

The Anglo Saxon race, so proud of its achievements, is wretchedly defective in the right use of will power; it is still exerting the brute force of its will power, unguided by intellect, almost as much now as in the time of William the Conqueror, when "might made right."

Has it not been the custom in educating children to repress the will power, to break it like that of a young colt, rather than to assist the child in his consciousness of his new found power and to teach him how to direct it in proper channels?

The lack of power of responsibility, so apparent everywhere in society, is the result of poorly trained will power. The constant cry for employment from the laboring class is an anomaly, when we consider how difficult it is to obtain even half-way skilled labor of any kind.

Our institutions may turn out any number of finely educated graduates, but they never can fit them for adaptation to life work, until they are so educated that they are in good possession of their will power, which understands how to build it, to control its egotism, vanity, self-love, envy and accompanying weaknesses. In life, we do not want a machine: we want a human being having ready at its command all its endowments to respond to the ever recurring emergencies that appear in daily life.

The weakness of the directive force of the will is evident in the desire of workers to shirk responsibility. There is demand for certain classes of workers which is never supplied, although both men and women, eminently fitted in many respects, stand by starving, when at least moderate salaries, and good homes, await them.

Care takers of houses, of children, of feeble persons of many classes and conditions,—what is more difficult to find than such care takers. The moment the master or governor is absent, responsibility ceases. Such

characters are often inefficient in taking care of their own bodily welfare even.

Are there no initial steps that may be taken by instructors of children to exercise their will power under proper conditions, to examine children as to their mental qualities upon their entrance into the public school, if unfortunately there is no opportunity for individual treatment of the child under more careful guidance ?

If a child cries for the fire is it best to refuse it arbitrarily, or bring it near enough to the fire so that the sensation of heat is sufficient to satisfy its wants in that direction ?

Vanity, envy, passion of various kinds can be treated in such a manner by inventive and ingenious instructors as eventually to give the child what is called self control and enable it to stand on its own feet *morally.*

THE ORIGIN OF PLAYING CARDS. By STEWART CULIN, Director Museum of Archæology, University of Pennsylvania, Philadelphia, Pa.

[ABSTRACT.]

AN explanation of the origin of playing cards, with illustrations.

THE ORIGIN OF MONEY IN CHINA. By STEWART CULIN, Director Museum of Archæology, University of Pennsylvania, Philadelphia, Pa.

[ABSTRACT.]

AN explanation of the origin of the *ts'ien* or current money of China with an exhibition of specimens.

MUSTACHE STICKS OF THE AINUS. By STEWART CULIN, Director Museum of Archæology, University of Pennsylvania, Philadelphia, Pa.

[ABSTRACT.]

AN explanation of the significance of the so-called "mustache sticks" of the Ainus of Yesso, Japan, with an exhibition of photographs.

NOTES ON THE BUSHMEN OF TRANSVAAL. By GEORGE LEITH, Pretoria, South African Republic. (Communicated by F. W. PUTNAM.)

SYMBOLISM IN ANCIENT AMERICAN ART. By Prof. F. W. PUTNAM and Mr. C. C. WILLOUGHBY, Peabody Museum, Cambridge, Mass.

[ABSTRACT.]

AN abstract of this paper can be hardly more than a brief description of a few of the numerous drawings which have been prepared for the illustration of the art of the various peoples of America. Many of these drawings were exhibited to the Section in the form of enlarged and colored diagrams by means of which the various figures, forming the complex designs could be more readily traced than is possible in a black and white illustration.

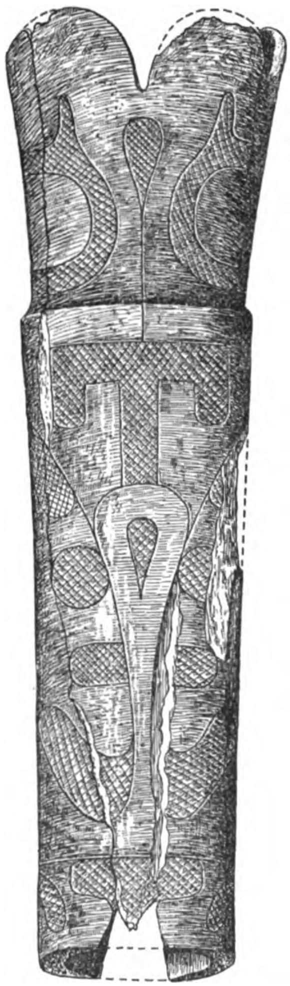


FIG. 1. Incised carving on human femur, Hopewell Mound. ¼

In presenting the paper Professor Putnam alluded to his study of the subject during the past quarter of a century, and to the large amount of material which he has brought together during that time. He called attention to the fact that Mr. Willoughby, his assistant, had been intimately associated with him in these studies during the past two years.

The marked development of conventionalism and symbolism in the art of the people who built the old earthworks in the Ohio valley and southward, indicates their connection with certain peoples of the southwest and of Mexico and Central America. It also furnishes one more point of evidence that the Ohio earthwork builders were more closely allied with the early stock, of which the ancient Mexicans were a branch, than with the tribes of the eastern part of the continent. The art of the eastern tribes,—with the exception here and there of slight resemblance which can easily be accounted for by survival from ancient contact,—is of an entirely different character with different motives and different symbols; whereas this old art of Ohio is closely related to that of Mexico and Central America, and many of the symbols are identical. There is a certain resemblance in methods of technique, as also in the duplication of parts of a design to produce the double or so-called heraldic figures, between these carvings from the Ohio mounds and those from the northwest coast of America.

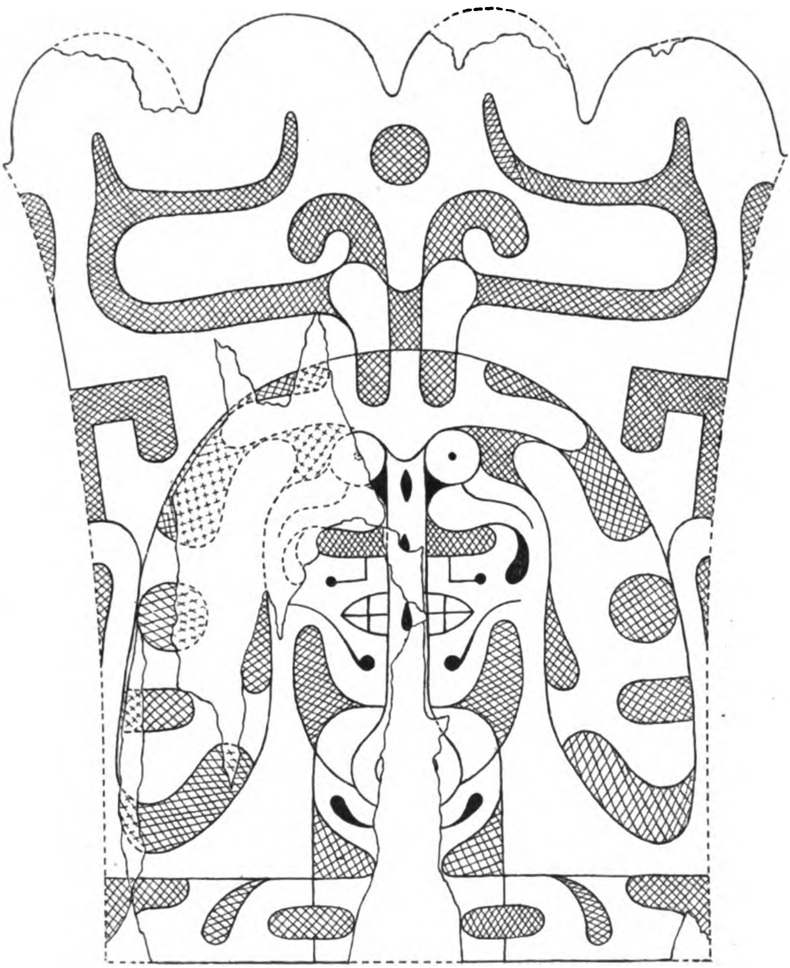


FIG. 2. Tracing from fig. 1. ⅓

The well-known Cincinnati tablet, here figured, is now the property of Mr. Robert Clarke of Cincinnati, who kindly furnished the photographic reproduction showing the tablet of full size.

The illustrations of specimens from the Hopewell mounds are from the collection now in the Filed Columbian Museum in Chicago. These specimens were obtained by explorations carried on by Professor Putnam while acting as Chief of the Department of Ethnology of the World's Columbian Exposition. The exploration of these mounds was under the immediate direction of Mr. W. K. Moorehead, acting as field assistant.

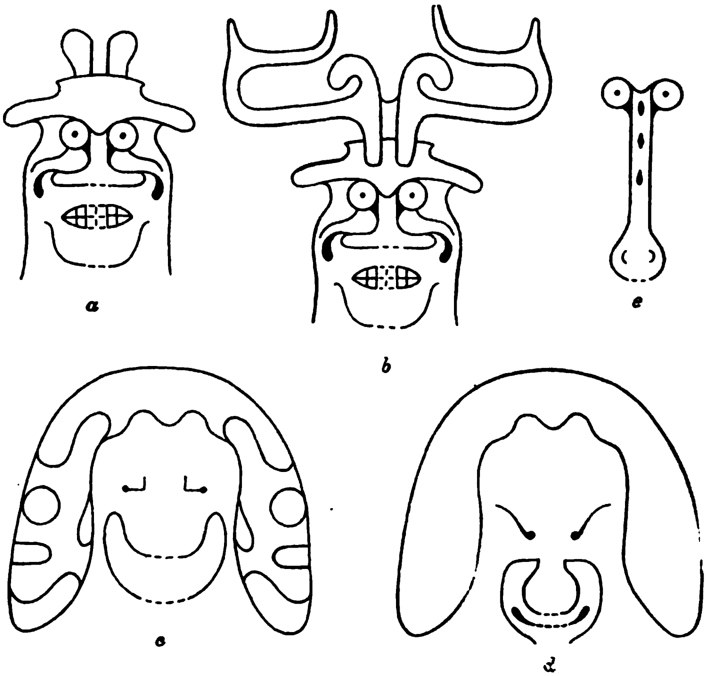


FIG. 3. Tracings from fig. 2. ½

The specimens from the Turner and other mounds of Ohio are in the Peabody Museum at Cambridge, and were obtained during the past twenty years by the explorations of Professor Putnam and Dr. Metz.

The two shell discs from Tennessee are also in the Peabody Museum, and they were obtained during the exploration of mounds, a quarter of a century ago, by Rev. E. O. Dunning, under the direction of the Museum.

Fig. 1 is a carving upon a piece of human femur which had been cut and highly polished. Fig. 2 shows the complicated design forming several heads and faces combined with the symbolic eye of the serpent god, which

is often united with that of the sun god. This close union of the serpent and sun symbols is a characteristic feature of the worship of this great southern group of peoples. Fig. 3 shows several parts of the design separated from the other portions. In this connection, the headdresses found with skeletons in the same mound are of special interest, as we here see the actual use of headdresses of a similar character to those shown in the complicated design carved on the human bone. Figs. 4 and 5 show these headdresses, which are made of hammered copper plates with the antlers of wood covered with thin copper. Fig. 4 represents the growing antlers as in *a* of Fig. 3; and Fig. 5 the full antlers as in *b* of

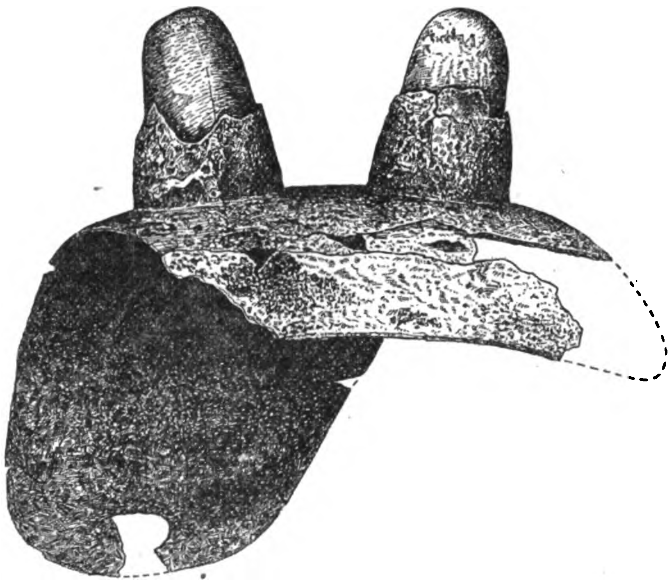


FIG. 4. Copper head-dress, Hopewell Mound. ½

Fig. 3. Fig. 6 represents a single antler of copper which was found in the same mound.

Fig. 7 is the tracing of a complex design incised on the surface of a portion of the ulna from a human arm. The two figures represent the design as spread flat; that is, as if the bone was split from opposite sides, thus showing the combination of lines by which the distinct figures in the design are formed. The lower portion of this bone was destroyed by the altar fire. Fig. 8 is the left hand drawing in Fig. 7 *reversed*. The small figures above Figs. 7 and 8 show the prominent central designs.

Fig. 9 is a piece of human femur with incised designs representing the serpent combined with the bear and other symbols. Fig. 10 shows the

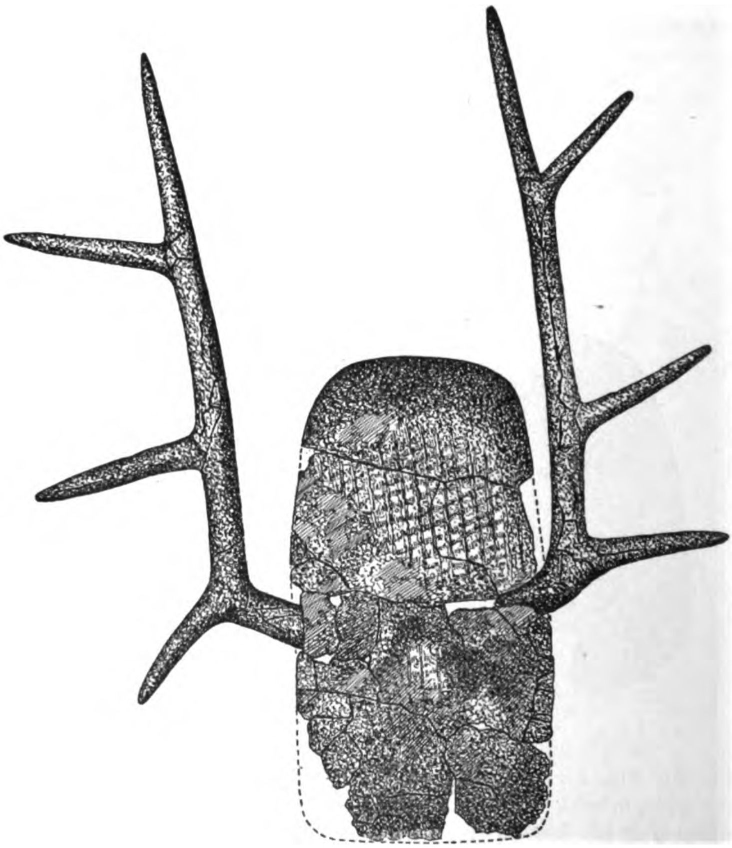


FIG. 5. Copper head-dress, Hopewell Mound. ¼

design as cut through the centre of Fig. 9 and spread flat. Fig. 11 is the serpent symbol combined with that of the sun in the centre, with the symbolic eye forming the scroll on each side. Fig. 12 shows the design in Fig. 9 *reversed*, and is probably the bear and sun symbol combined. Similar designs are expressed in some of the earthworks of the Ohio valley.

Fig. 13 shows the bear and other symbols carved on a piece of antler, and Fig. 14 is the bear symbol cut from a hammered piece of native copper.

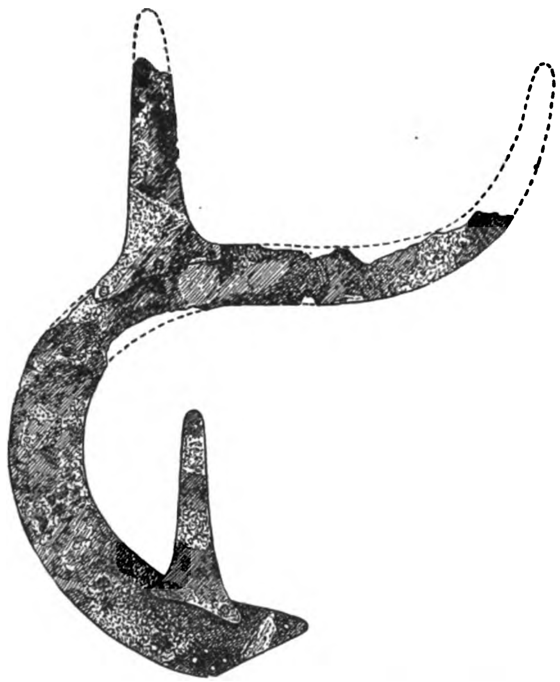


FIG. 6. Copper antler, Hopewell Mound. ½

Fig. 15 is the "Cincinnati Tablet" showing the serpent combined with the human form. A careful study of this complicated design shows it to be formed on the same principle as those carved on bones. Not only is the duplication of the right and left sides apparent, but there is also a remarkable duplication of the different parts when they are reversed, the right and left and the upper and lower. This is shown in the reduced outlines given in Fig. 16, of which *a* shows the human figure as in Fig. 15. We notice here the ears, *cc*, as straight bars on each side of the head; the eyes, the two dark circles each with two projecting curved

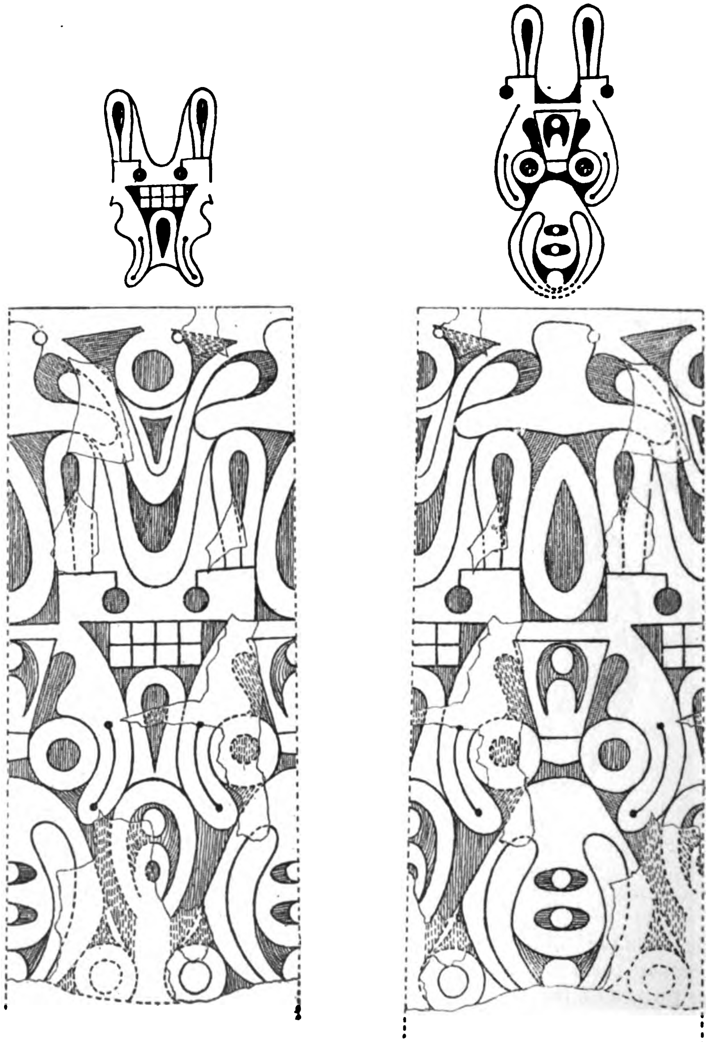


FIG. 7. Incised carving on human ulna, Turner Mound.

arms; the nose, the lozenge-shaped space; and the broad mouth, the transverse white space below. The body includes the two oval figures in the centre, which are duplicates of each other as will be seen by folding the upper over the lower. The arms curve outward and the hands are shown at *dd*, with the fingers pointing inward; the three middle fingers are represented by the trefoil between the long curved thumb above and the long little finger below. The legs project from the lower portion of the body and are bent upwards at the knees, *ff*; the feet with the toes pointing outward, *ee*, are duplicates of the hands. Here the duplication is with the left foot and right hand turned upon each other and reversed; the same with the right foot and left hand; while the duplication is again shown by folding the hands and feet of one side upon the opposite side.

In the reverse of this human design, shown in Fig. 16 *b*, the two serpent heads are shown at the bottom of the figure, with the slender necks extending off on each side and connecting with the central portion of the design; *j* indicates the jaw of each serpent head. The symbolic eye with its double arms is seen above the jaw, and the four horns or plumes of the serpent, two above and two below curving backward, are of the same character as shown on many other serpent heads from Mexico and Central America. (See Fig. 27 for various forms of serpent heads.) The double reversal of the several portions of the whole design can readily be seen by following the lines on the opposite sides of these reversed outlines, *a* and *b*.

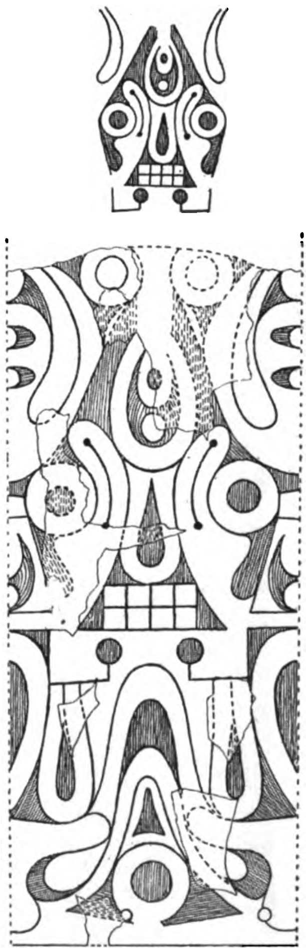


FIG. 8. Reverse of left hand drawing of fig. 7.

Fig. 17. In this design, cut from a piece of hammered copper, are the same symbolic serpent eyes and the essential lines of the human face, as in the head of *a*, Fig. 16. The spaces in the human-serpent head of the Cincinnati tablet are represented in the copper design by the seven notches above and below as shown in Fig. 18. The central bar is probably intended for the nose, and the border on right and left sides for the ears.

FIG. 9. Human femur, Hopewell Mound. ½

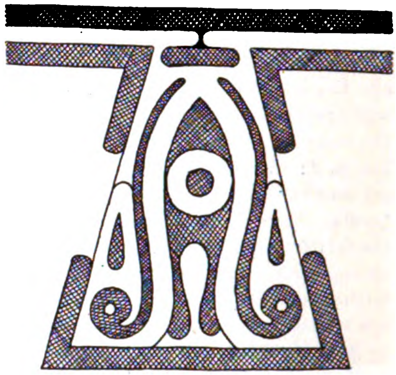


FIG. 11. Serpent symbol from centre of fig. 10. ½

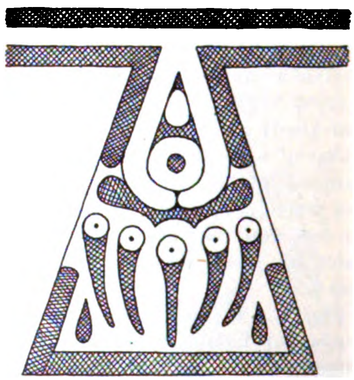


FIG. 12. Bear symbol from centre of fig. 9, reversed. ½

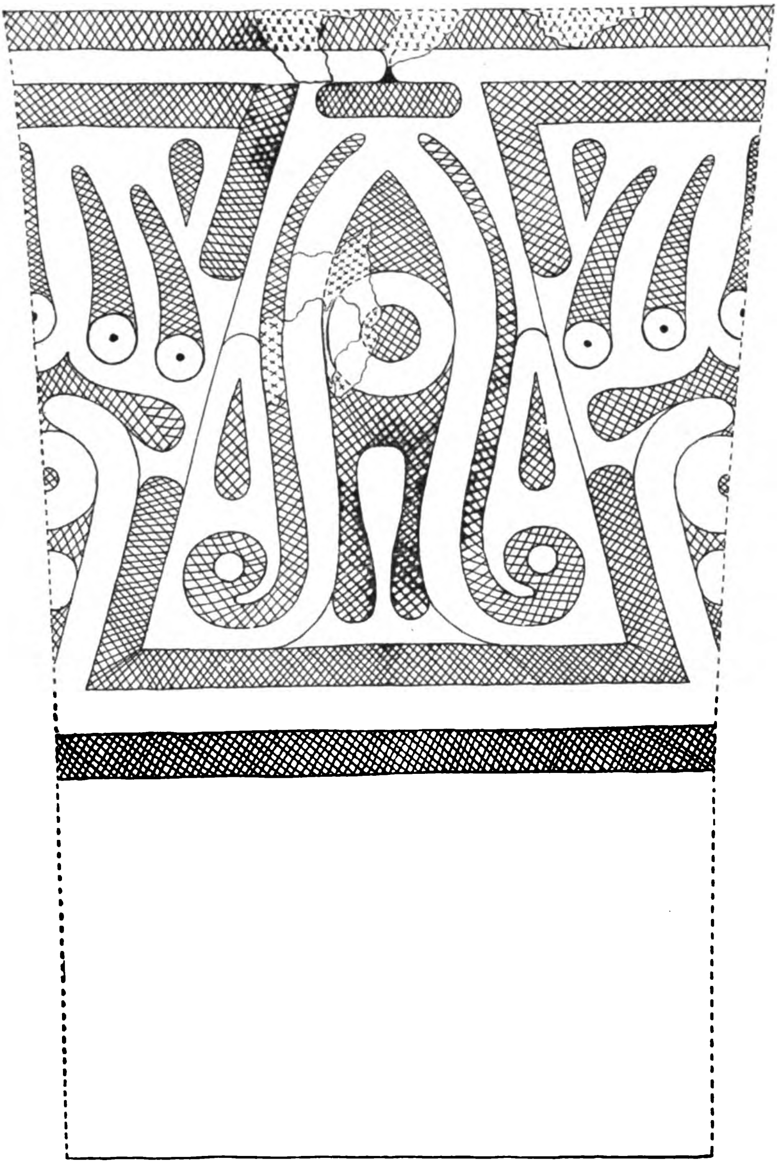


FIG. 10. Design on fig. 9. $\frac{1}{1}$

Fig. 19. This symbolic eye is cut from antler with a large pearl set in the hole in the central portion. The identity of this design with the two similar eyes of the copper piece is evident.

Fig. 20. On this spherical stone the serpent symbol is incised, as shown in Fig. 21, and here, also, the symbolic eye is the principal figure. This eye is also shown in the glyphs on the ancient monuments of Copan, Honduras. (See Fig. 22.) It can also be seen in slightly modified forms in several of the other figures here given in which the serpent is apparent.

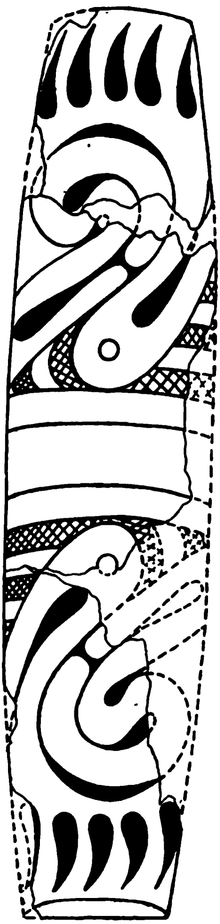


FIG. 13. On antler, Hopewell Mound. ½

Fig. 23 shows the serpent cut from a piece of mica. In this we must probably compare the long arm proceeding from the central portion of

FIG. 14. Copper, Bear symbol, Hopewell Mound. ½

the eye with the curved lines meeting at a point in the design on the stone shown in Fig. 21; also with the other representations of this singular symbolic eye.

Figs. 24 and 25 are serpents carved on shell discs from mounds in Tennessee. In Fig. 24 the cosmic symbol is combined with the serpent.

Fig. 26. This remarkable piece, cut from a sheet of hammered copper, is not only a representation of the serpent head, but includes also in the design the symbolic eyes, each with the two arms, as in the Cincinnati tablet, and the cosmic symbol with the "four quarters" indicated by the bars issuing from the central sun-circle. This cosmic symbol (see Figs. 28-35), or the sun, four quarters, horizon or boundaries of the earth, and sometimes the water, is common in America as elsewhere, and probably formed a prominent part in ceremonials and in pictographic expressions of various peoples.

FIG. 15. The "Cincinnati Tablet," Mound in Cincinnati. $\frac{1}{1}$

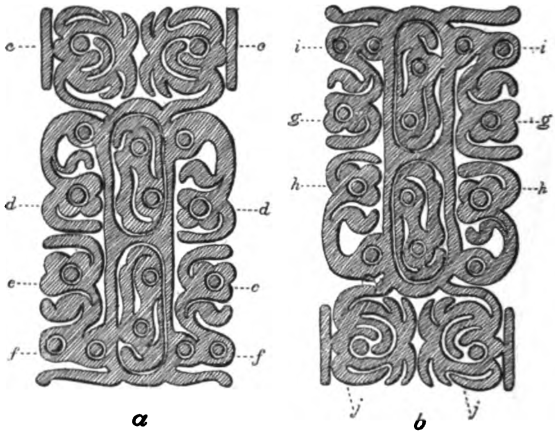


FIG. 18. Outlines of figures on Cincinnati Tablet, ½. *a*, Human figure; *b*, reversed showing serpent heads at bottom.

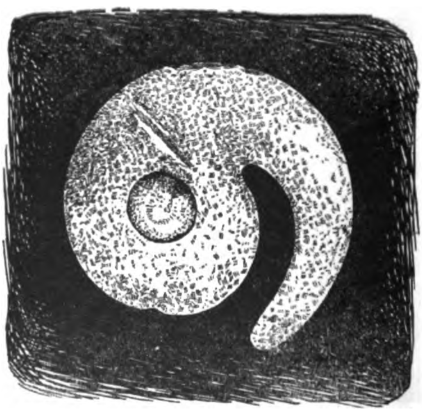


FIG. 19. Cut from a piece of antler with a large pearl inserted. Grave under Mound of Turner group. ‡

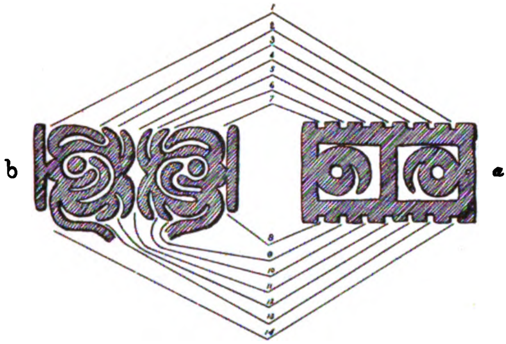


Fig. 18. *b*, from Cincinnati Tablet; *a*, the same symbols cut from copper.

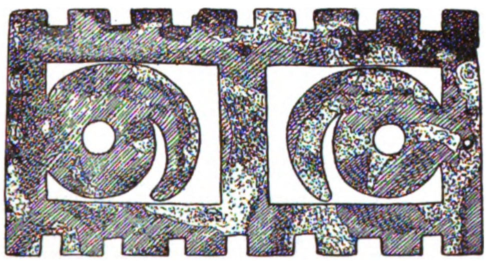


Fig. 17. Copper, Hopewell Mound. ½

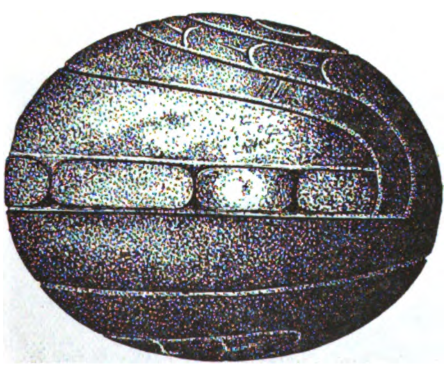


Fig. 20. Carved stone, Liberty group, Ohio. ½

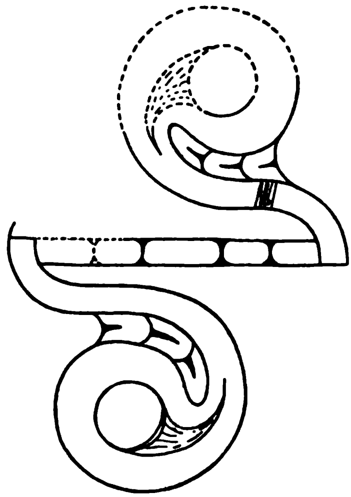


FIG. 21. Serpent symbol carved on stone (fig. 20). ¼

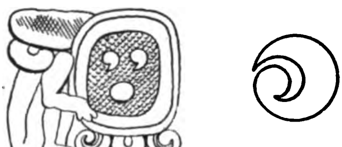


FIG. 22. A glyph on monument, Copan, Honduras; *a*, the symbolic eye.

FIG. 23. Cut from mica, Turner Mound. ⅛

FIG. 25. Shell disc, Brakebill Mound, Tenn. ½

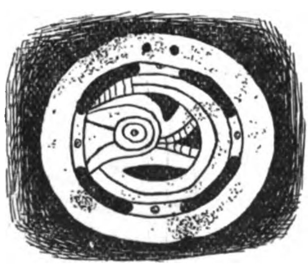


FIG. 24. Shell disc from Lick Creek Mound, Tenn. ½

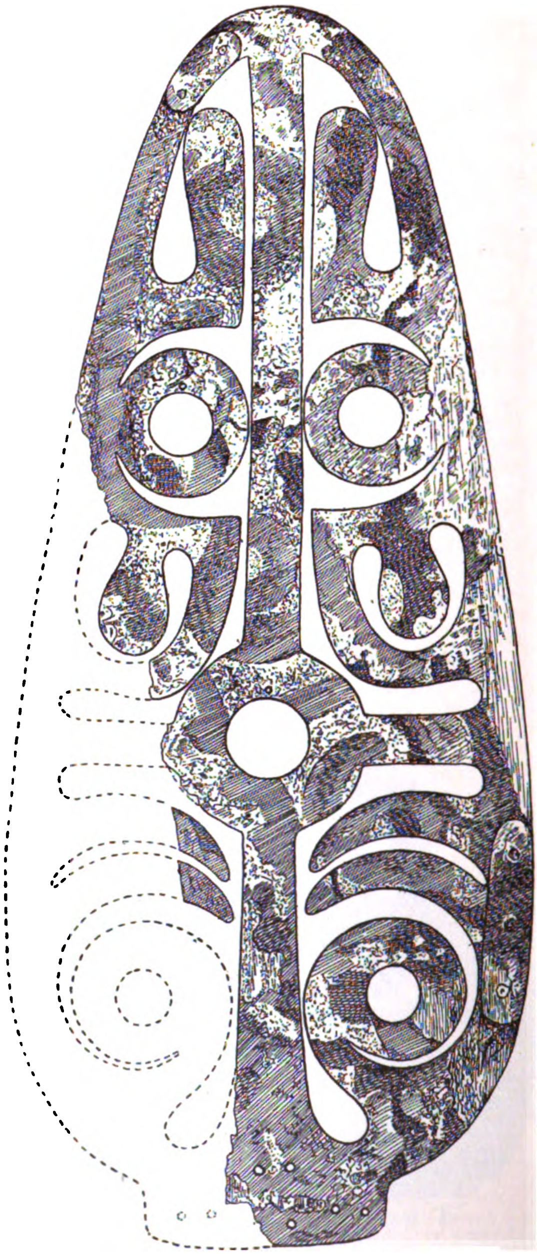


FIG. 26. Cosmic and Serpent symbols combined.
Copper, Hopewell Mound. ½

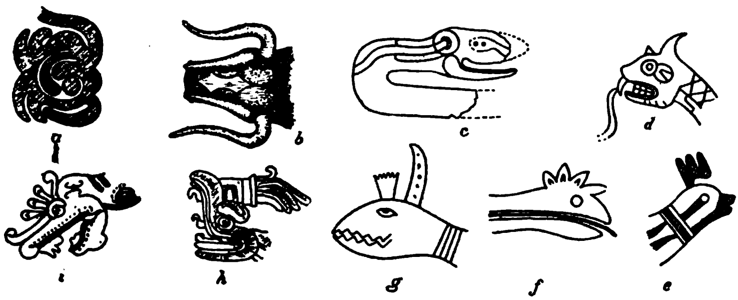


FIG. 27. Various forms of Serpent heads; *a* Cincinnati tablet; *b*, stone carving from Turner Mound, Ohio; *c*, cut in mica, from Turner Mound, Ohio; *d*, on a stone disc, from mound in Alabama; *e*, on pottery vase from mound in Arkansas; *f*, painted on pottery vase from New Mexico; *g*, from a rock-carving in Arizona; *h*, from a Mexican manuscript; *i*, from a Maya manuscript.

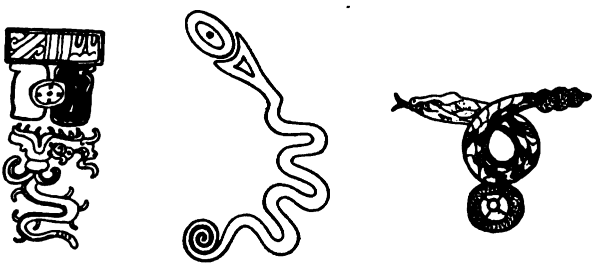


FIG. 28. Serpent and Cosmic symbols combined. Right hand figure, from Mexican MS.; middle figure, the Serpent Mound, Ohio; left hand figure, Maya MS.

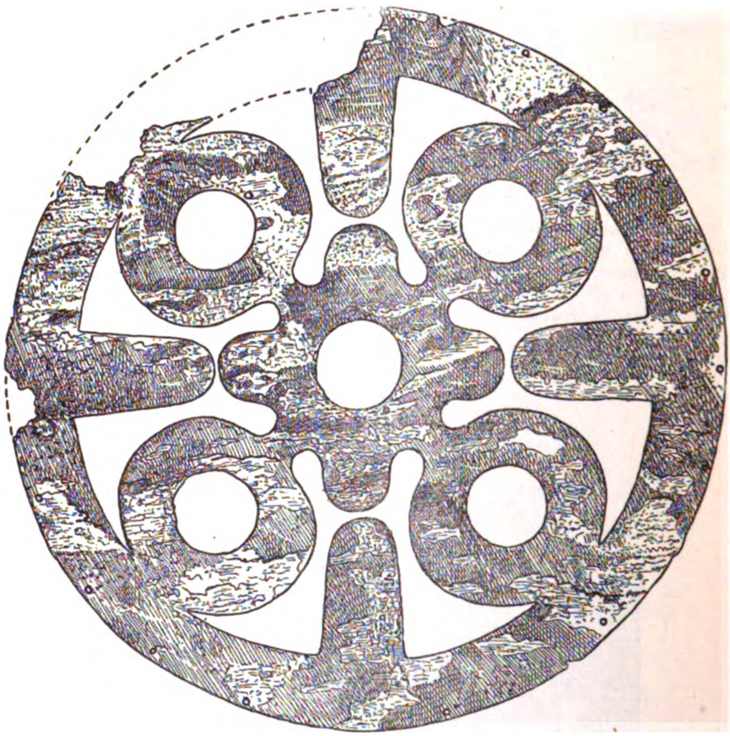


Fig. 29. Cosmic symbol, copper. Hopewell Mound. ½

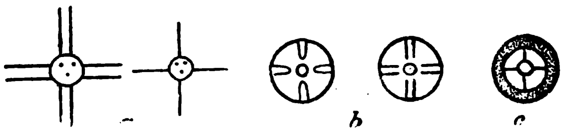


FIG. 33. Cosmic symbols. *a*, Arizona; *b*, Maya; *c*, Mexico.

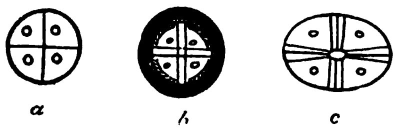


FIG. 32. Cosmic symbols. *a*. *c*, Maya; *b*, Copan.

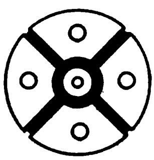


FIG. 30. Cosmic symbol on ear ornament of copper. Ohio.

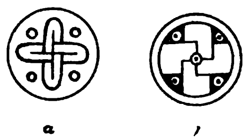


FIG. 31. Cosmic symbols. *a*, Mexico; *b*, Tennessee.

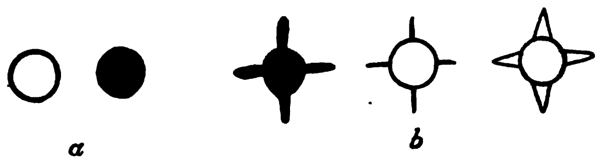


FIG. 34. *a*, Sun symbols; *b*, symbols of the sun and four winds. Omaha and Sioux.

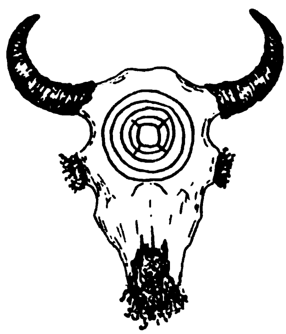


FIG. 35. Symbol of the sun, the four winds, and of the earth, air and water, painted upon a buffalo skull. Omaha.

SECTION I.

SOCIAL AND ECONOMIC SCIENCE.

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ADDRESS

BY

B. E. FERNOW,

VICE PRESIDENT, SECTION I.

THE PROVIDENTIAL FUNCTIONS OF GOVERNMENT WITH SPECIAL REFERENCE TO NATURAL RESOURCES.

It is with considerable hesitation, that I undertake the duty, which you have seen fit to impose upon me, namely, of addressing you in a representative manner on a subject of Economic Science. For I may not claim to be an expounder of its laws, although engaged in its practical application; much less do I pretend to be a representative of the science,—if science it be.

This doubt alone—whether there is as yet such a thing as economic science—should unfit me for my present position before you, who have chosen this field of human inquiry as your specialty and hold it, I presume, as correlated with equal value to all the other sciences established as such.

But even conceding the right to such a correlation, which I know is maintained practically by the most eminent men, I am still inclined to doubt the propriety of the title which is applied to this section of the Association for the Advancement of Science, for I conceive that the intention could not have been to single out for representation in the great concourse of sciences one portion and one method of the greater separate field of inquiry, but that the title of Economic Science was in reality supposed or intended to be inclusive of all those branches of knowledge which deal with the phenomena of political, commercial, economic and social life of mankind, and which might be comprised in the all-inclusive name of Social Science—Anthropology in section *H* forming its historical or descriptive part.

At least since this section *I* was formed, if not before, it has been recognized, that political economy or economics was only a branch of a larger science, the science of the social biology of man, and that this branch could not be satisfactorily developed for any length of time without reference to. and without an equal development of, all the other branches of the system. Hence to be abreast with the times, at least in classification and nomenclature, we should rechristen this section to be the section of Social Science, which to my mind would assign it its proper place in the concourse of sciences represented in the Association. Social Science would then have to determine the forces and laws and to explain the phenomena of social life and, finally, as applied social science, to direct the development of the political, economic, commercial and social intercourse of man; these four aspects of social life being all-inclusive and at the same time so differentiated as to admit of their more or less separate study and largely—never entirely—independent development.

Perhaps I owe you an explanation, if not an apology, for my doubt as to whether we are *as yet* justified in classing this branch of knowledge as a science. This doubt, which I notice is shared by others, has arisen from the observation that the discussions in this field are still progressing to a very large extent on *a priori* reasoning, instead of *a posteriori*, as true science demands. The scientific method of procedure is too often neglected.

It seems that as yet both writers and practitioners rely more upon proposed working theories, than upon discovered laws, and hence we find the economists divided into camps and schools, differing in the most fundamental principles; partisanship, preferences, bias of education, personal opinion, sentiment, dogmatism, rather than facts, truths, and natural laws, predicating unalterable consequences, are at the very foundation of the superstructure.

All science to be sure requires working theories as methods for further development, and in these there may be differences of conception which lead to diversity of opinion as to the probable truth, such as the dynamic and fluid theory of electricity, the undulatory and corpuscular theory of light. But these theories are the scaffolding outside of the unfinished building, not the foundation that is placed on broad unalterable law, on facts observed, which can be tested, and it is the organized and related condition of these facts and laws, their cause and effect, interdependence, their struct-

ural aggregation which give to the building its name and character of "Science," although the building may not yet be, never is to be, finished.

Do we have such a substructure and sufficient foundation walls for Social Science, or even for that part which has been most developed, Political and Economic Science, to deserve its appellation, or is it only a scaffolding from which to work in the erection of the building with a few isolated foundations of some of its walls, not too firmly placed and often lacking connection and mutual support?

Is not even the plan of the building so ill understood that the masons on each of the four walls have worked independently, without reference to what the whole is to be, and some of them think that they are building an independent and separate structure instead of an integral part of the whole; so that for instance the worker on the economic side is jealous of and quarrelling with the sociologist? (*Vide* Discussions in the latest Proceedings of Am. Economic Association.)

It was not, however, my purpose to carp about names and classification, although I believe that proper nomenclature and classification assist greatly in advancing science; or to quarrel with the builders, except to warn them against dogmatism, which is unscientific, and against narrow conceptions of the sphere of their work, which is detrimental to its efficiency. I wished to emphasize that foundations are still needed on which to erect the building of Social Science and mutual supports for the walls, that have hitherto been left to stand independent; that the forces and stresses need to be more carefully calculated and their direction determined with more precision before the building may satisfactorily proceed. Finally, I desired to use this occasion for calling the attention of the workers on this building, to the advantages they could derive for their fundamental work from this Association, which affords intercourse with the workers in other biological sciences, an advantage which the student of Social Science cannot afford to neglect.

While I thus desire to emphasize the advantages that come from such association, it will be part of my theme to point out the danger and impropriety of considering the social development of man as too closely analogous, nay as of the same order as the biological development of plant and animal, an impropriety which is perpetrated by that school which has potently influenced economic thought for many decades, known as individualists, with Herbert Spencer as their most powerful exponent.

The revolution, which the fascinating philosophy of Darwin has brought into the manner of contemplating and explaining the life and development of plant and animal world, has with these men asserted itself in their manner of contemplating and explaining man's life. To be sure, the same forces which determine the progress of development in plant and animal world are also active in the human world. We may easily agree that the same means employed in their struggle for existence, namely, selection, rejection, competition and adaptation, are also the means which aid in the perpetuation, development and improvement of the human race, or its better adaptation to the conditions of existence.

So far as the simple *biologic* development of man is concerned this may readily be conceded; and even in *social* development, these were perhaps alone at work in the earliest history of mankind, when it just emerged from the state of mere brutishness, and are the only ones in some portions of it even now. But if we content ourselves to accept these same forces and means as the only ones now at work in shaping *social* development, we shall fail in understanding, explaining, or directing that development. The two qualities by which the human individual differs from the brute, the head and the heart, the intellect and the soul, the reason and the emotions, feelings, affections—breeding the one wisdom, and the other character, the one directing, the other impelling action—have had, and will in future have still more influence upon the social development of the race. It is the existence and powerful influence of these two factors, these additional variables, in the social development that have rendered its analysis so difficult, and that have kept our knowledge of human affairs from becoming an exact science sooner.

We do not deny the existence of the germs of these two qualities and occasional exhibition of the same in the animal, but the capacity of developing them, as far as we know, is possessed by man to such an infinitely greater degree as to approach difference in kind.

With these two qualities two new aims were added to those which man has in common with the rest of living creation, namely, to secure the development of these two qualities; but what is more important in his social development, they lead him and enable him to interfere with the working of the natural laws of physical development, to give direction to that development without the necessity of the struggle for existence as motive, and to influence even

and transform the conditions of existence, which necessitated the struggle.

These qualities develop, however, only in society to such a degree as to become the moving force of further social progress. Associated effort has bred and fed them. At first probably the same instinct that moves the ants and bees and other animals to association, was alone active in man, but as these two qualities developed by application, they became the directive forces both of individual and social effort, and became stronger than the mere biologic forces.

Not that thereby human development becomes a "bewildering exception to the reign of universal law"—a kind of solitary and mysterious island in the midst of the cosmos given over to strife of forces without clue or meaning; for morals and reason also develop under laws, but the development becomes more complex, a function of more variables, a result not of physical, but psychic forces as well, and of rational deliberation.

If the progress of man in his higher social development had relied on biologic forces alone, it is not likely that he would have exceeded the stage in which we find the lowest savages who, with all the faculties of higher man latent, and the biologic laws almost alone active, remain on the plane of the animal.

To quote Prof. Joseph LeConte: "I have from time to time shown that there are certain limitations to the application of the doctrines and methods of biology to sociology—that in every case such limitation is the result of the introduction of some new principle characteristic of *humanity* as distinguished from *animality*, of *reason* as distinguished from *instinct*."[1]

And Lester F. Ward, after careful analysis, goes so far as to state rather strongly: "that the whole farrago which has so long passed for political economy is true only of irrational animals and is altogether inapplicable to rational men." [2]

Whatever value then all the other evolutionary biologic forces have had in the *animal* development of man, in the *social* development, in the progress of moral and material civilization, the feelings, emotions or affections have played a much more important part, which has generally been greatly undervalued, until Lester F. Ward in his Dynamic Sociology, and again in his Psychic

[1] Pop. Sci. Mo., Feb., 1879, p. 430. [2] Psychic Factors, Ward, p. 279.

Factors of Civilization forcibly called attention to this fact. He recognizes these, however, only as dynamic forces, without direction, conceding to the intellect alone the power of direction. I am not prepared to deny altogether direction to the emotions, just as the force of gravity is both dynamic and directive. I am inclined to keep these two exhibits of the human mind distinctly and separately as two social forces of unequal value and direction, giving to the emotions the highest value in the past, to the intellect a more and more increasing importance and modifying the direction of the former. At any rate we shall have to agree that the emotions have had and have the largest share in shaping man's civilization, and the recognition of this fact will appear as important with regard to the subject I have proposed to discuss.

Neither the individualists nor the socialists have recognized this undeniable fact, which history develops at every step. The latter, *i. e.* the *rational* socialists, in their plans of improvement of social conditions, fail to take account of it as well as of the biologic factors. They propose to hasten the millennium by making coöperation compulsory and reason rule supreme, suppressing the *individual* as in a colony of ants, each existing only as a part of the whole.

The individualists, on the other hand, desire to let our progress depend or to shape itself entirely under the working of the natural law of competition, suppressing as far as possible the *organization* which has served to develop the moral and intellectual forces,—in fact they propose to reduce us as far as possible to the conditions of the brute world. They expect, to be sure, but with what right it is difficult to see, that the individuals will as such, independently of society, develop the social instinct, will desire the common good even at the expense of his own good and, finally, will seek voluntarily coöperation as a result of superior intelligence. And they claim that he will do so sooner and with less friction if let alone. It is not very clear, why such a result should occur, how the free exercise of competition is to produce coöperation, which is its very antithesis. "Coöperation," as Ward states it, "always tends to reduce competition, and competition denotes want of coöperation," and he further points out that the seeming coöperation as a result of competition is in reality only competition between corporations or classes, but in no sense the coöperation which establishes the same aims in all members of society.

"We are told," says he, "to let things alone and to let nature

take its course. But has intelligent man ever done this? Is not civilization itself with all that it has accomplished the result of man's not letting things alone, or of his not letting nature take its course?"[1]

In other words, the whole difference between civilization and other forms of natural progress is that it is a product of art; of artful coöperation, and this coöperation has been coerced rather than voluntary; coerced first by the few and, as intellectual and moral forces developed, by the many.

And now we are asked to give up the advantage of this coöperation, laboriously developed, to return to the beginning as far as that is possible; and for what?—to experiment, and see whether the individual if left alone to the laws of competition would not again develop coöperation, which after all even the individualist admits with chagrin is preferable to competition.

To quote Ward again: "Competition not only involves the enormous waste, which has been described, but it prevents the maximum development, since the best that can be obtained under its influence is far inferior to that which is easily obtained by the artificial, *i. e.* the rational and intelligent removal of that influence. Hard as it seems to be for modern philosophers to understand this, it was one of the first truths that dawned upon the human intellect.

"Consciously or unconsciously it was felt from the very outset that the mission of mind was to grapple with the law of competition, and as far as possible to resist and defeat it. The iron law of nature, as it may be appropriately called, was everywhere found to lie athwart the path of human progress, and the whole upward struggle of rational man, whether physical, social or moral, has been with this tyrant of nature—the law of competition—and in so far as he has progressed at all beyond the purely animal stage he has done so triumphing little by little over this law, and gaining somewhat the mastery in the struggle."[2]

The individualists who expect better success from the purely animal method have been bred by the undeniable fact that, in many respects, governments have failed to perform their functions well, although even in this respect fair investigation will show that, considering the conditions and the general limitations of men, this stricture cannot be sustained to the degree, as may at first glance

[1] Psychic Factors, Ward, p. 286. [2] Psychic Forces, Ward, p. 261.

appear to the casual observer. Now, instead of improving the methods of government, they propose to curtail the functions; instead of giving direction to the social forces—which will not be downed—they propose to neglect them, to substitute the biologic forces.

Just as the chemists, who are attempting to determine dietaries and construct universal soups by chemical synthesis, overlook the existence and claims of the palate, catering alone to the stomach, so the individualists and many economists deal with man as a machine of a given physiological construction and put in motion by physiological forces, overlooking that psychological forces are his main motive power, "that he is to be lured not pushed in the way of productive effort;" or at least, that however far for his animal development the laws of animal biology, the laws of nature, may be allowed to prevail, for his truly human development the laws of mind and especially of heart must and will interfere. In this development not competition but coöperation is a necessity.

This rather lengthy reference to that school of sociologists, whose motto is the reduction of the functions of government, who have so strongly influenced and still continue to influence not only thought but government activity, appears necessary, whenever we desire to discuss government functions; for whether we subscribe to the views of the *laissez-faire* school, or to those of what we may call in contradistinction the *faire-marcher* school, the discussion will take a different turn.

Between the socialist and the individualist stands the true democrat, in whose creed society, the demos, stands recognized as the supreme ruler with ideals of progressive civilization as the goal of associated effort, giving all liberty possible to individual activity, that does not interfere with the good of society. That good he believes to be the moral and intellectual development and material comfort of all its members, present and future, and he believes that it is attained not by negative, or merely restrictive methods, but by positive, active, methods; ameliorative, or coercive, whenever the interests of society present or future would suffer by noninterference with individual activity or neglect. The functions of this government lie wherever coöperation of the whole will accomplish the end aimed at by society better than individual effort, avoiding interference where individual effort suffices to obtain the end of society; above all, he does not consider government as an

evil and outside of himself, but as a good created by himself for the attainment of his highest human ideals, and furthermore he always contends for the welfare of the future as well as of the present. This is the creed to which I subscribe, and until sociologic science furnishes us with the knowledge of fundamental, incontrovertible laws, which with unfailing necessity produce invariable effects, we shall have to state our creeds before preaching. This may not be a very scientific proceeding; but where, as I have stated, emotions play such a prominent part, science and exact reasoning must suffer.

"The end of Government is the good of mankind." This briefest and broadest statement of the purpose of government, which breathes the true philosophical spirit of Locke, is much less a formula, as Huxley calls it, or a working theory, than an historical fact, expressive of the visible trend which the evolutionary development of society has taken and which the careful student of the history of mankind can now deduce much more readily than even Locke: the broadly humanitarian tendencies of the governments of to-day, as compared with those of old, stand out unmistakably in spite of the many narrow, clannish policies that still prevail.

Yet the active politician or statesman would hardly find it practicable to formulate and direct the measures and methods for such an end on such a broad basis. He requires limitations. If he succeed in accomplishing or promoting the good of that portion of mankind, which is segregated as a nation, he may feel satisfied that he has also done his part in promoting the good of mankind.

There may, then, to be sure, still remain antagonisms among the various governments which have to be smoothed away in that dim future which is the dream of the individualist, when the true "Civitas dei," the ideal nation comprising all mankind, is to materialize; "in which every man's moral faculty shall be such as leads him to control all those desires which run counter to the good of mankind, and to cherish only those which conduce to the welfare of society." (Huxley, Nihilism.)

For the present this cosmopolitan activity appears premature even to discuss. We shall do well, therefore, to hold fast to the wisdom of minding our own affairs, to regulate our own government in such a manner, as to attain the good of our own nation.

However poorly at times this end of government has been attained or attempted in practice, however its functions have been

perverted, however diverse the methods employed, the conception that government exists for the purpose of the good of the aggregation of mankind to which it extends, may be asserted to have now universal acceptance among all peoples. The questions on which people differ are as to how the good of the nation is to be attained; it is as to methods rather than objects, that diversity of opinion has always prevailed.

Even the individualist, when closely pressed and not too callous, will agree to this object of government, but he will insist that this object, the good of the nation, is attained by inactivity rather than by active exertion of the government, by allowing the individuals to work out their own salvation (or damnation) amid the free and unrestricted play of natural forces, rather than by making them do so. *Laissez-faire* instead of *faire-marcher!*

They overlook that the objects and the motives which inspire the action of the individual as such are and will remain entirely different from those of the aggregation of individuals. As individual he will strive and does strive to work out that "unsocial peculiarity of desiring to have everything his own way and opposing others." Beyond the gratification of his own desires and an interest in his immediate offspring and perhaps into the second generation, he lacks as individual, and naturally so, incentive to advance or to calculate with the future. It is only as citizen, a member of organized society, as a social being, in community with others, as a reasoner and philosopher with conceptions of the objects and aims not only of individual existence, but of society as a whole, of the race, that he allows considerations of the future to influence his action, that he realizes the higher human ideals: in this communal activity, "he feels that he becomes more a man."

Social man, then, is not satisfied alone with the preservation of his species by means of unconscious adaptation to its surroundings, but *consciously* he adapts himself to his surroundings, and more than that, he influences and adapts the surroundings to himself; nay, he influences the future consciously and therein if in nothing else he differs from the animal world and has outgrown the laws of their development.

How this has come to be so we need not inquire; it is so, that is enough. It is the momentum of education, of gradually accumulated tendencies that drives him on the path towards social and ethical improvement, with ideals in the future always before him.

What we call the feeling of duty, which is the motive spring of most men's altruistic actions, is nothing but this momentum, which the accumulated education of generations has imparted to us and which produces the conscious civilizing progress of the race, always setting up new ideals when the old ones have been attained or reason has dislodged them.

This civilizing tendency is upheld, however, only in the association and is lost sight of by the individual as soon as he is dissociated and acts apart from his fellow members. This sounds like a paradox, that the tendencies, desires and actions of the whole should differ from the tendencies, desires and actions of its parts.

Yet even the sage of antiquity, Aristotle, recognized that you could never arrive at the whole by a mere addition of the units composing it, that while the prosperity of the whole implied the prosperity of all individuals which it includes, yet in our treatment of social questions we must proceed from the standpoint of society, not from that of the individual; the welfare of society could not be secured by attention to individual claims. And we observe this every day in larger or smaller assemblies of men; the emotions, feelings, provoked in the assembly, lead to entirely different actions, than if each member separately had acted upon his own motion. The feeling of patriotism, which inspires many actions of nations and is of a kind with the civilizing tendencies referred to, can hardly be thought of outside of organized association; and so all the altruistic and ideal aspirations of the best and most advanced apostles of humanity, which have in view the improvement of the conditions of the future, the advancement of the race, are not of an individualistic, but of communistic nature, possible only in society and attainable only by associated effort.

Government then, the instrument of associated action, the expedient of organized society, the brain and hand of the nation, becomes the means not only of securing social existence, but social progress, and out of this object of government arises what I have called the providential functions of government, which have in view the future of the nation, as contrasted with the current functions of government which refer to the more immediate needs of social, political, commercial and economic intercourse.

Government becomes the representative not only of communal interests as against individual interests, but also of future interests

as against those of the present. Its object is not only for the day, but includes the *perpetuity* of the well-being of society and the perpetuity of such favorable conditions as will conduce to the *continued* welfare and improvement of the same; in short its activity must be with regard to continuity, must provide for the future, must be providential.

Mark, we do not create this special providence for the individual, but for society; the individual will have to work out his own salvation to a large extent with the opportunities for advancement offered by society, but society itself can only act through the State or government, and as the representative of the future the State cannot, like the individual, "let the future take care of itself."

In our present state activity and legislation there is as yet but little realization of its providential character. Even the question of education, which partakes of that character providing in part for future improvement, is only imperfectly considered from that point of view. The questions of the franchise as well as that of immigration, both of which are of greatest influence upon the future composition and condition of our society, are much more often discussed with reference to the rights of present members than with reference to the future of society.

The one condition of social life in which the action of the present influences the future almost more than in any other direction, namely, the condition of the means of material existence and their economical use (the economy of resources), has received perhaps the least recognition in practice as well as in theoretical discussion; and especially is this absence of attention to this most important branch of economics noticeable in English literature.

The reason probably is that the need of careful analysis of the factor of social life has as yet not been pressing. But as the world has been explored in all corners, and the extent of its resources has become more nearly known, and as it is being rapidly peopled everywhere and the causes of depopulation are becoming less, the warnings of Malthus and Mills come home to us with new force and the study of the nature, relation to social life and development, and the economy of resources becomes a most important branch of social science, which will overshadow some of the other branches, now appearing all-important. When the questions of the extension of suffrage to women, of tariff, of taxation, of coinage and currency, which are all merely incidents, shall have sunk into the

background, the question of the economy of the resources which constitute and sustain the political, commercial, and social power of the nation, long neglected, will still claim attention; for only those nations who develop their national resources economically, and avoid the waste of that which they produce, can maintain their power or even secure the continuance of their separate existence. A nation may cease to exist as well by the decay of its resources as by the extinction of its patriotic spirit.

Whether we have a high tariff or no tariff, an income tax or a head tax, direct or indirect taxation, bimetallism or a single standard, national banks or state banks, are matters which concern, to be sure, the temporary convenience of the members of society, but their prejudicial adjustment is easily remediable; when ill effects become apparent, the inconveniences may be removed with but little harm to the community and none to mankind at large, or to the future. But whether fertile lands are turned into deserts, forests into waste places, brooks into torrents, rivers changed from means of power and intercourse into means of destruction and desolation —these are questions which concern the material existence itself of society, and since such changes become often irreversible, the damage irremediable, and at the same time the extent of available resources becomes smaller in proportion to population, their consideration is finally much more important than those other questions of the day.

It is true that as individuals the knowledge of the near exhaustion of the anthracite coal fields does not induce any of us to deny ourselves a single scuttle of coal so as to make the coal-field last for one more generation, unless this knowledge is reflected in increased price. But we can conceive that as members of society, we may for that very purpose refuse to allow each other or the miner to waste unnecessarily. That this conception is not absurd, and may be practically realized without any strain in our conceptions of government functions, is proved by the fact that it has been carried out in practice in several cases without opposition.

Absurdly enough we have begun such action with reference to our resources where it is perhaps of least consequence, as for instance, when by the establishment of hunting and fishing seasons and by other restrictions, we seek to prevent the exhaustion of the fish and game resources. This is a good illustration of the fact that emotion rather than reason, sentiment rather than argument,

are the prime movers of society. It was hardly fear of the exhaustion of this readily restorable resource and economic reasons that led to this protection of our fisheries and game, but love of sport that gave the incentive. And again, it needed the love of sport to set on foot the movement for the improvement of the roads in the United States, which the realization of true economy had not the power to bring about.

In some countries the waste of forest resources is more or less guarded against, and the waste of water is at least to some extent a matter of control by society.

While we do not prevent single individuals from ruining themselves financially and hazarding the future of their families, we do prevent associated portions of the community, corporations, towns, and cities, from jeopardizing their future by preventing them from extravagant expenditures and contracting of debts. This, too, is perhaps less designed for the future, than to protect present members against undesirable burdens.

There are enough precedents established to show that whatever the greed and selfishness of the individual may dictate, society recognizes its right to interfere with the individual not only for its present objects but even for considerations of the future.

To recognize how far any of the resources must become objects of national concern it is necessary to understand their relative significance for the present and for the future development of society or of the particular nation. From this point of view I have at some former occasion classified resources under four heads, namely:—

1. Resources inexhaustible.
2. Resources exhaustible and non-restorable.
3. Resources restorable, but liable to deterioration under increased activity.
4. Resources restorable, and apt to yield increased returns to increased activity.

Of the first class, hardly any can be mentioned that are usually denominated as resources; land, water, air, and the forces of nature would fall under this class, but since it is not so much these things themselves as the conditions in which they are found that make them resources, and since these conditions are alterable by human agency, their inexhaustibility with reference to human requirements is not entirely established. With the land it is rather the fertility of the soil that makes it a resource, except so far as it

serves for building purposes. With the water, except for the absolute necessity of life, it is its desirable distribution—terrestrial and atmospheric—which constitutes it a resource in the sense of satisfying human wants.

Of such resources as are in time exhaustible without the possibility of reproduction we may mention the mines. The supply of coal, "the bread of industries," is calculated to last not more than three or four centuries in Europe, although scarcity is expected long before that time, and in our own country we are told that anthracite coal mines do not promise more than sixty years of supply under present methods of working. The silver and gold mines, upon the basis of which Nevada became a state, are said to show signs of exhaustion. Oil fields and natural gas wells of very recent discovery belong to this class of exhaustible resources. With their consumption in satisfying our wants they are destroyed forever.

The timber of the virgin forest and its game, the water power of the streams, largely dependent on the condition of the former, the fisheries, and to some extent the local climatic conditions, are resources of the third order, capable in most instances, of reproduction or restoration under human care; after having been deteriorated by uneconomic exploitation or by change of contingent conditions, as when brooks and rivers are lessened in volume or else filled with flood waters and débris in consequence of forest destruction.

Lastly, as resources restorable and yielding increased returns to increased activity, we should find most of those resources which are the product of human labor, industry and ingenuity, the accumulated wealth, the accumulated educational fund and other conditions of civilization, the people themselves, capable of performing labor.

It might appear that of the natural resources the soil with its fertility, capable under intensive cultivation of increasing its yield, should be placed here; but, when this increased activity is unaccompanied by rational method, this resource too will deteriorate almost to a degree where its restoration is practically precluded.

Altogether, while possibility of restoration has served in our classification, practicability, *i. e.*, the relation of expenditure of energy and money to the result, will have to influence the ranging of the resources in these classes as far as state activity with regard to them is called for.

Often it will be a difficult task to assign a particular resource to a proper position with regard to its bearing upon social interest, but conservatism, which in the logical policy of society, will lead us in cases of doubt to lean toward the presumption that the interests of society are more likely to suffer than those of the individual: and a mistake in curtailing private interests will be more surely and easily corrected than a mistake in not having in time guarded social interests.

To appreciate properly the position in any given case, we shall have to weigh the present and future significance of the resource, the likelihood of its permanence, and the likelihood of its fate under private treatment, whence the necessity of bringing it under sovereign control of the state and the quality of the control will appear.

That each individual case will require its own consideration and adjudication holds there as well as with legislation in reference to industrial action, and the general classification here attempted offers simply a suggestion as to the general points of view from which each case must be considered.

With the conception of the government before us as outlined, namely, as the instrument to secure the possibility not only of social life but of social progress, the representative of communal interests as against private interests, of the future as against the present, we can get an idea as to how far the providential functions of the state are to be called into action.

The policy of governmental control over waterways, roads, and lands falling under the operation of eminent domain is well established in most governments. The ownership and management of railways has proved itself as in the interest of society in several countries. It should be extended with even more reason to all exhaustible, non-restorable resources. That, in the interest of society and of production as well, the mines should belong to the state in order to prevent waste, we may learn from the actual experience of France, where they are state property and only the right to work them under supervision is leased to private individuals.

Of the restorable resources it is apparent that with regard to those which yield increased returns to increased labor the interests of society and of the individual run on parallel lines. Where interference of the state in their behalf exists, it is not from providential reasons. The ameliorative functions only are called into

requisition. Whatever tends to stimulate private activity is to be promoted, whatever retards development of intensive methods, to be removed by government. Industrial education, cultural surveys, bureaus of information, experiment stations, and other aids to private enterprise constitute the chief methods of expressing state interest with regard to these resources.

The three great resources upon which mankind is most dependent and which, therefore, demand first and foremost the attention of the state, are the soil as food-producer, the water and the climatic conditions. The utilization of these three prime resources by agriculture forms the foundation of all other industries; or, as Sully puts it, "Tillage and pasturage are the two breasts of the state." It is true the manufacturer increases the utility of things, but the farmer multiplies commodities: he is creative, and he therefore above all others can claim a right to first consideration on the part of the state.

Whatever may be thought of the practicability of Mr. George's plans and of his conclusions, the fundamental principle upon which he bases his land theories will have to be admitted as correct. Society, the State, is the original owner of the soil. Whether the ownership should continue is another question.

The soil is a valuable resource as far as it is fertile and capable of agricultural production; the fertility while liable to deterioration can with few exceptions be said to be restorable, and it certainly yields increased returns to intelligent increased labor. It ranks, therefore, with those resources which can be left to private enterprise, calling only for the ameliorative functions of the government. But while this condition prevails, when the soil is put to agricultural use, it does not exist as long as the soil is not so utilized. By the withdrawal of large sections of land from such use, society is harmed and deprived of the benefit which it would derive from a use of its property. The proper distribution and the appropriation of the soil to proper use form, therefore, fit functions of government control.

The rational appropriation of soil (land) to either farm use, pasturage or timber production, one would be inclined to think, could be left to the regulation of private intelligence; yet the fact is, that the thin rocky soils of mountain districts are worked for a scanty agricultural crop, when they should be left to timber; while

thousands of acres in fertile valleys are still under the shade of virgin forests.

Water and climate are the accessories to agricultural production and supplement the resources of the soil. Not objects of private enterprise directly, except in a limited manner, it is evident that, as far as they or the conditions which influence them can be at all controlled, they should be under the direct control of the State.

A rational management of the water capital of the world in connection with agricultural use of the soil will become the economic problem of the highest importance as the necessity for increased food production calls for intensive methods. And in connection with this problem, it must become a matter of State interest, by a rational management of existing forests and by reforestation at the head waters of rivers and on the plains, to secure the conditions which make a rational utilization of the waters possible. For without forest management, no water management is for any length of time possible, no stable basis for continued productive agriculture, industries and commerce.

I may be allowed for the sake of illustration to state more in detail the considerations which pertain to the one resource with which I am most familiar, the forest.

The virgin forest is a natural resource, which answers two purposes of civilized society. On the one hand, it furnishes directly desirable material; on the other hand, it forms a condition of soil cover, which influences directly or indirectly, under its own cover and at a distance, conditions of water-flow, of soil and of local climate.

To the individual it is in the first place the timber, the accumulated growth of centuries, which has an interest to him and which he exploits for the purpose of making a profit on his labor and outlay. The relation of the forest to other conditions, direct or indirect, immediate or future, hardly ever enters into his calculations. Now the exploitation of this resource is a necessity of our civilization, but the economic conditions of our country and for that of any new or partially developed country, especially the condition of the distribution of population and consequent necessity for a long haul of the bulky material, bring it about, that only the best kinds of timber and the best cuts of these can be profitably moved to market. Hence, since profit is the object, exploitation is by necessity wasteful.

Again culling the forest, which means removing the good kinds, although apparently not as destructive to the resource as clean cutting, leaves the ground to the kinds not useful or less useful to man, to the weeds of the forest. This means, not only occupation of the ground by undesirable kinds, but prevention of the reproduction of desirable kinds, which being reduced in numbers, are hence at a disadvantage in the struggle for existence, and especially in the struggle for the necessary light under the shade of the growth that was left.

Thus even under legitimate exploitation, such as the interests of the individual exploiter and the economic conditions of the country predicate, the future of the resource must be injured, its value deteriorated by changing its composition and quality.

Now comes the further danger of neglect which arises from the fact that when the marketable timber is gone the interest of the individual in the forest is also gone. The conflagrations which follow the wasteful exploitation with the accumulated débris of lumber operations left in the woods kill and damage not only the remaining old timber, but all the young growth of desirable kinds.

An additional vegetation of weeds, tree weeds as well as others, adapts itself to the new conditions and further prevents the re-establishment of desirable kinds.

Often these fires burn out the soil itself, which consists of the mould from the decay of litter accumulated through centuries, and thus not only the practicability but the possibility of restoration is prevented.

Thus by leaving this resource to the unrestricted activity of private individual interests it is quickly exhausted, its restoration made difficult and sometimes impossible, its function as a material resource is destroyed.

It is possible so to exploit the forest, that the natural reproduction of the best kinds in even superior quantity and quality is secured, but the methods which must be employed to this end necessarily entail curtailment of present revenues, and, as the new crop takes decades, nay, a century and more to grow to maturity, the incentive for the short-lived individual to curtail his present income for the sake of an income in the uncertain future is but slight. Where, as in older countries, the institution of family estates had secured stability and permanency of holdings, the interest in the future was greater and staved off the evil day of forest devastation,

but even there the rapidity of change of the modern world asserts itself and the safety of this resource in private hands has become doubtful.

The other functions of the forest, namely, that which it exercises as a soil cover by preventing erosion of the soil, by regulating waterflow, changing surface drainage into subsoil drainage and thereby influencing the water stages of rivers and its possible relation to the local climatic conditions, preëminently render it an object of government consideration.

The attempt to get the largest profit from his labor, which is the only incentive of private enterprise, is bound to lead to unconservative management, especially where the maintenance of favorable forest conditions from protective considerations is necessary; for here again the need of leaving valuable material for the time being, the need of curtailing present revenue for the sake of the future, and for the sake of other people's interest, can hardly be expected to be appreciated by the private individual.

Here the general principle of Roman law, *Utera tuo ne alterum noceas*, prevention of the obnoxious use of private property, establishes readily the propriety of State interference, and by *alterum* we are to understand not only the other citizen of the present, but of the future as well.

We see then that the forest resource is one, that under the active competition of private enterprise is apt to deteriorate and in its deterioration to affect other conditions of material existence unfavorably; that the maintenance of continued supplies, as well as of favorable conditions, is possible only under the supervision of permanent institutions, with whom present profit is not the only motive. It calls preëminently for the exercise of the providential functions of the State to counteract the destructive tendencies of private exploitation. In some cases restriction of the latter may suffice, in others ownership by the State or some smaller part of the community, a permanent associated institution, is necessary.

I close with the hope that the students of political economy, associated with this Section, will see that this branch of their science, the economy of natural resources, so important and yet so much neglected, requires on their part a fuller and more careful consideration.

PAPERS READ.

TAXATION IN THE UNITED STATES WITH SUGGESTIONS FOR ESTABLISHING A FORM FOR COMPARING THE TAXATION OF DIFFERENT COUNTRIES. By EDWARD ATKINSON, Boston, Mass.

IT is becoming evident that the most urgent problem with nearly every government in the world is how to secure a sufficient revenue without impairing the productive energy of the people of the several nations or states by whom continents are possessed. This question is as urgent in some of the richest sections of the globe which have been but recently opened to civilization and commerce, as it is in some of the older states in which the limit of taxation has been reached accompanied by national bankruptcy or a resort to a forced loan by the issue of legal tender paper money.

It is desirable to compare the relative burden of taxation, and to that end the following form of statement of the amount of the taxes and method of assessment in the United States is submitted as a form.

The following tables give an analysis of all taxes imposed in the United States for national, state, county and municipal purposes.

The principal source of information on which these statements rest is the special census report made by Mr. J. K. Upton, special expert of the Census Department of the United States, by whom the receipts and expenditures of national, state and local governments in the census year 1890 have been compiled and published. The statistical data which are not derived from this report are derived from the official statements of the United States Treasury. The estimates of the value of the national product are based on various authorities and upon my own investigations.

Total amount of revenue collected in the census year 1890 for all purposes,	$1,040,473,013
Collected by the national government including postal revenue,	$461,154,680
Collected by cities and towns, partly estimated, for expenditure by cities, towns and customarily by counties and states,	329,635,200
Collected for expenditure by counties, partly estimated,	133,525,493
Collected for expenditure by states, territories, and the District of Columbia,	116,157,640
Total,	$1,040,473,013
Total expenditures by national, state and local governments for all purposes,	$915,954,055
Sum applied to the reduction of public debts,	124,518,958
	$1,040,473,013

General Division of the Expenditures.

Expended by the national government including the postal service,	$352,218,614
Deduct the postal service which is mainly recovered from the sale of stamps, there being a slight deficiency varying year by year which is covered under the general expenditures, ...	66,259,547
	$285,959,067
Expended by states, territories and District of Columbia, except for public schools, ...	77,105,911
Expended by counties, except for public schools, partly estimated, in the division with cities and towns, ...	114,575,401
Expended by cities and towns, except for public schools, partly estimated as above, ...	232,988,592
Expended for public schools, ...	139,065,537
Net cost of government,	$849,694,508

Net cost of government per head of population:
$13.65, £2.8049, Francs 70.747, Marks 57.305.

This expenditure, omitting postal service, may be classified as follows:

Beneficiary.		
Pensions paid by the United States Government, .	$106,936,855	
State and municipal charities, ...	39,958,816	
Support of Indians, ...	6,708,047	
		$153,603,718
Administrative.		
Support of civil governments, ...	$266,412,130	
Support of army and navy, ...	57,543,817	
		323,955,947
Interest on Public Debts.		
National, state and municipal, ...		82,748,423
Constructive.		
Support of schools, ...	$145,583,115	
Construction and maintenance of highways, . .	72,262,023	
Construction and maintenance of public buildings and parks, ...	59,803,844	
Improvement of rivers and harbors, ...	11,737,438	
		289,386,420
	Total,	$849,694,508

The charges to which the people of the United States are subjected aside from the reduction of public debts, therefore amount per head of population to the following sums:

	$	£	Francs.	Marks.
For beneficiary purposes, ...	2.47	.5075	12.802	10.369
Administrative, ...	5.20	1.0685	26.951	21.830
Interest, ...	1.33	.2733	1.893	5.583
Constructive, ...	4.65	.9555	24.100	19.721
	13.65	2.8048	65.746	57.503

The area of the United States, omitting Alaska, is a fraction under 3,000,000 square miles of 640 acres each, equal in the aggregate to 1,920,000,000 acres, upon which the charge of $849,694,500 comes to a fraction over forty-four cents per acre. Less than one-fifth part of this area is under the plough; probably one-half is arable land; probably twenty-five per cent in addition is valuable as forest or suitable for pasture; the remainder consists of mountainous sections or in small part of arid desert. These are merely general statements not intended to be exact. The charge or tax for public purposes if assessed wholly upon the portion of the land which is in productive use or under the plough would average approximately two dollars ($2) per acre. But it will be remarked hereafter that a large part of the municipal assessment is upon real estate in cities. It is not probable that the tax which falls upon the owners or occupiers of arable or pasture land comes to an average of one dollar ($1) per acre.

A more important consideration is the proportion of taxation or public expenditure to the gross income of the people. It is of course impossible for any one to reach anything but an approximate estimate upon this point. Official estimates are made by the census authorities and by other officials of the value of farm products at the farms, of the value of forest products at their source, of the value of mining products at the mines, and so on. The data are also compiled of the value of manufactured products at the factories. But there are of necessity a great many duplications in these estimates which cannot be wholly eliminated, as, for instance, the conversion of grain into meat and dairy products, the conversion of wood and metal into buildings, tools and implements, and the conversion of fibres into fabrics. I do not, therefore, regard these computations as anything but material to be applied for the purpose of estimating the annual income or product. They would be sure to mislead on account of these necessary duplications if accepted as final.

I have in several instances extended the valuation of the crude products of the country through their various transformations into finished goods and wares by methods of a somewhat complex order which have been satisfactory to myself.

I have also proved the results of such estimates approximately by working from the known factors of the average earnings of all classes in the community who are occupied for gain, adding taxes, profits and other elements that enter into the cost of production and distribution. By these methods which are dealt with in my book upon The Distribution of Products (G. P. Putnam's Sons), I have satisfied myself that the value of our national product in the year 1880 at the points of final distribution for consumption came to two hundred dollars' ($200) worth per head, including that part of each crop which is consumed upon the farms without purchase or sale.

In the interval between 1880 and the census of 1890 the quantities of nearly every product were greatly increased; the cost was diminished; the means of distribution were augmented; the wages or proportion of product falling to those who are customarily named "the working class" was

largely augmented; but the prices of nearly every important class of products were much lessened at the points of consumption although maintaining a relatively steady value at the points of production.

The advance in money value is not therefore to be estimated at the same ratio with the increase in quantity. I am satisfied that the annual product of the census year 1890 divided by the population would have amounted approximately to two hundred and twenty-five dollars' ($225) worth per head. On this basis, the gross value of our annual product in 1890, disregarding small fractions, came to fourteen billions of dollars ($14,000,000,000.). The net expenses for national, state and municipal purposes in that year amounted to $849,694,508, which represents a fraction over six per centum of the total product devoted to the support of government.

The margin of error in this estimate is not large. It may be affirmed with almost positive certainty that the proportion of the product assigned to the support of the government in 1890 and to such payment of public debts as was made in that year, a total of $1,040,473,013, could not have been less than six per centum of the gross product, probably amounted to seven per centum, and could not have exceeded eight per centum of the gross product, the variation in per cent depending upon a greater or less valuation of the product.

The next point which calls for attention is the relative burden of the national taxes as compared to those which are assessed for state and municipal purposes.

In 1890 the total expenditures of the United States Government, less the postal service, amounted to $291,028,440.

	$	£	Francs.	Marks.
Per capita	4.749	.9578	24.614	19.957

This sum could not have been less than two per cent upon the annual product and could not have exceeded two and one-half per cent.

The average expenditures of the United States Government for fifteen years from 1880 to 1894 inclusive have been very nearly the same as the ratio in 1890,—at times a little less,— later a little more.

Under the present administration these expenditures are being diminished ratably to population.

The average annual expenditures for a period of fifteen years has been as follows:

$	£	Francs.	Marks.
4.89	1.0048	25.345	20.525

The revenue of the national government is almost wholly derived from duties upon imports and excise taxes on liquors and tobacco. The government has a small income from sales of public lands, taxes on bank note circulation, and other small factors which do not need special treatment.

The sources of revenue for fourteen years from 1880 to 1893 will be found in the subsequent table, the fiscal years 1894 and 1895 being omitted

as they have been slightly affected by the free silver panic. It is desirable in such a treatise as the present to deal with normal conditions, such as prevailed from 1890 to 1892 inclusive. Specie payment had been resumed on a gold basis in 1880 and there were none but the ordinary variations in crops and trade down to the year 1893. The latter part of that year was slightly affected by the beginning of the panic.

If the figures of these two years were included the variation in the period would be but slightly affected. The following tables give a general conception of the sources of national revenue.

Tax on domestic spirits, yielding per head,	$1.312	
" " " beer, " " "	.373	
" " " tobacco, " " "	.605	
" " foreign liquors, " " "	.137	
" " " tobacco, " " "	.160	
Total tax on liquors and tobacco,		$2.587
Tax on sugar for the first 11¼ years at the rate of .925 per head, tax then removed:		
Average for whole term,	.764	
Small internal taxes,	.077	
Miscellaneous permanent receipts, sales public lands, etc.,	.534	
		$1.375
		$3.962
Duties on all other imports than liquors and tobacco,		2.576
Total taxation per head,		$6.538

The subsequent table gives the expenditures in detail for the fi[illegible] years 1880 to 1894 inclusive.

The average cost of each department of the government, aside from postal service, for fifteen years has been as follows:

	Cents per head.
Cost of civil service administration, legislative, judicial, consular, etc.,	.39640
Public buildings for civil use, post-office, custom-houses, etc.,	.07386
Support of army,	.56610
Cost of forts, etc.,	.00600
Improvement of rivers and harbors,	.18600
Support of navy,	.25260
Construction of naval vessels,	.08826
Miscellaneous—District of Columbia, etc., refund of taxes, unlawful sugar bounties, premium on bonds purchased, etc.,	.92266
Total,	2.49188
Interest on public debt,	.90880
Cost of government and interest,	3.40068
Pensions,	1.48760
Total expenditure,	4.88828
Taxation in all forms, per head,	6.53800
Expenditures of all kinds,	4.88828
Difference,	$1.6[illegible]972

Making no allowance for a slight difference in cash in the Treasury, June 30, 1879, as compared to June 30, 1894, this difference of $1.65 per head enabled the Treasurer to meet the postal deficit, to pay for the support of Indians and for extinguishing their title to large areas of Indian land, and to reduce the public debt by over $1,100,000,000, besides paying a heavy premium on the bonds purchased.

The national debt at its highest point, a few months after the end of the Civil war, was a fraction under three thousand million dollars ($3,000,-000,000). It had been reduced to less than one thousand million dollars (1,000,000,000), when new loans were effected to the amount of about five hundred million dollars ($500,000,000) for the purchase of silver bullion, which rests mainly in the Treasury in the form of silver dollars or of uncoined bullion. If that reserve or deposit of silver is estimated at its market value and deducted from the present debt of the United States the net amount which we now owe is approximately eleven hundred million dollars ($1,100,000,000).

It is now manifest in the natural course of events the per capita expenditure of the United States will diminish ratably to the population by the falling in of pensions. It may, therefore, be assumed as approximately certain that a continuation of the national taxation at the present amount of five (5) dollars per capita will meet all the expenses of the government with a sufficient surplus over to pay the remainder of the national debt within the next twenty years.

The taxes which are imposed for city, county and municipal purposes are almost wholly assessed directly upon property. The method of assessment varies in the different states. It is customary, however, for these taxes to be levied in one assessment. In New England, which is under the town and city system of government, all the taxes were assessed by town and city, the sum required by the county being paid over to the county, and the sum required by the state being paid over to the state.

The total expenditures in 1890 for the cost of local government, ...	$558,666,068
To which may be added the sum applied to the reduction of state, county and municipal debts, ...	15,582,892
Bringing the total assessment to .	$574,248,960

The amount of this assessment per capita was as follows:

$	£	Francs.	Marks.
9.22	1.8946	47.787	38.707.

There is of course a very great variation in the distribution of such taxes, the taxes in cities being ratably very much higher per capita or by the measure of property than they are in the agricultural districts.

Of this sum of local total taxation the amount collected by direct ad-valorem taxes upon real estate was $443,096,574.

The remainder was derived from special taxes on franchises, licenses and other minor sources.

It therefore follows about one-half the total revenue collected from the people of the United States for all purposes is derived from direct taxes upon property: about one-half from duties, excise taxes upon articles of common or general consumption, or by licenses and taxes on franchise. This division may be justified in consideration of the fact that the protection of property, the provision for highways and other similar purposes, rest upon the states, counties and towns,—while national defence and the protection of persons and the establishment of personal rights at home and abroad, rest upon the central government of the United States.

Taxes for the support of local self-government are therefore mainly collected from assessments upon property—the revenue for the support of the national government is almost wholly collected from articles of common consumption.

The foregoing memorandum is submitted with a view to some method being devised in other countries or by officials thereto designated by the United States Government, for ascertaining and sorting the respective revenues and expenditures of other countries, to the end that the relative burden of taxation and the relative cost of conducting the governments of nations, states or municipalities may be compared.

The writer has made an attempt to set off the items of revenue and expenditure of this and other countries one against the other, but has failed, the reason being that the methods of accounting differ greatly. It is therefore difficult if not impossible for one who is not conversant with the systems of account in other countries to set off the several items of expenditure or even of revenue one against the other with any certainty or precision. The following reasons for this undertaking are submitted.

The world is becoming more and more a neighborhood of which the different members can and will supply each other's wants in a continually increasing measure to the profit and benefit of all who are served by the conduct of commerce, the surplus of one nation being exchanged against the surplus of another to the mutual profit and benefit of all. This interdependence of states and nations has asserted itself throughout the last century in spite of wars, conventions, treaties, tariffs, variations in the unit or standard of value and all other obstructions.

It is manifest that by far the greater part of the commerce or exchange of services among men is of necessity limited to the domestic traffic. The international exchanges constitute a very small proportion compared to the home trade. But, on the other hand, diversities of climate, soil and conditions create international commerce, whereby one nation may relieve itself of an excess of some product, the other securing what it requires. It is noticeable that, in the early part of this century and the latter half of the last, this commerce asserted itself so strongly as to have led the smugglers by whom the prohibitions of the tariff of the era were overcome to be called the "fair traders," the legal fault being condoned in public estimation.

During the last half century the applications of science and invention have rendered international commerce more and more necessary and use-

ful. We can already foresee yet greater and more beneficent influences from the applications of modern science in the openings of the ways of commerce by the canals already constructed, yet more when those which are planned shall be completed, and by the extension of the railway and steamship service in continents which have only been opened to trade within the present generation.

The Suez canal has brought Asia and Europe into a close neighborhood. The projected canal between the Atlantic and the Pacific, if constructed, will alter the balance of the trade of the world. The canal which unites the Great Lakes in the United States around the falls of Sault Ste. Marie has exerted a most beneficent influence both upon the United States and the Dominion of Canada, bringing the timber, the ores, and the grain of the far northwestern territory to the use of the bread winner in the eastern parts of the United States, in Great Britain and upon the continent of Europe.

The annual tonnage which passes through the Sault Ste. Marie canal, three hundred miles north of Detroit, at the present time far exceeds that which passes the Suez canal year by year.

The opening of the canal at Kiel may be noted as another element in the conduct of peaceful commerce.

To whom then will fall the paramount influence in the next half century? It is with reference to this matter that the problem of comparative taxation assumes great importance, since one great factor, if not the prime factor in the effort of one nation in competition with the other for the supply of the wants of the world, consists in the relative burden of taxation. All profits, rents, wages, earnings and taxes must be derived substantially from the annual product, a small part of the product of the preceding year being brought over to the present and a corresponding part of the current year's product being carried over to the next. On the whole, mankind is always within one year or less of starvation and within two or three years of being naked and homeless. The commerce of the world must of necessity go on, in order that mankind may continue to exist; while the comfort and welfare of great masses of the people of every country will be commensurate with the freedom with which this commerce is conducted and the lessening burden of what may be called the destructive taxation of war or the constant preparation for war.

Regard being given to the burden of taxation, its relative influence upon the welfare or illfare of the people consists not so much in its proportion to the gross product as it does in its ratio to the margin of profit which may be derived from agriculture, manufactures or commerce. That profit whatever it may be is the incentive to the capitalist to develop all the arts both of production and distribution. If we compare the ratio of taxation of any state or nation to the gross value of its annual product, it may not appear to be a very serious matter. If we, however, compare the rate of taxation with the probable ratio of profits that may be derived from any particular art it becomes manifest that the lightest taxed nation will secure the largest profit and may therefore take to itself the greater share in production.

If it should be proved by comparison of the relative burden of taxation on the plan of the present paper either in ratio to population, in ratio to arable land, or in ratio to the net profit which may be derived from production, that the burden of constant preparation for war had become unbearable and can be no longer borne without disaster; if it should be proved that the destructive taxation for war purposes is the prime cause of want and of pauperism; then the remedy for such wrongs may be in sight if it should prove that that nation which contains within its own area the greatest natural resources, the best schools, the smallest army, and which supports a navy only for the protection of commerce and not for its destruction, may hold the paramount position among the machine-using states and nations,—then it would follow of necessity that the principle of liberty must prevail and must lead in the end to the removal of militarism, and of government by privilege and lastly to the abatement of the corresponding evils of nihilism, anarchism and communism, which are the complement of government imposed from above without the consent of the governed.

It is to this end that I suggest to my coadjutors in Economic Science the expediency of devising plans and methods for establishing a systematic study of the comparative taxation of different countries.

EQUALITY OF OPPORTUNITY: HOW CAN WE SECURE IT? By JAMES L. COWLES, Farmington, Connecticut.

THE fundamental postulates of our modern political economy, the grand bases of all possible progress toward the equalization of opportunities, are "the free movement of labor and the free movement of capital. It was to make these postulates practical realities that the inventors of the steamboat and the locomotive gave to the dead earth a circulating system, and it was to crown their work that the electrician created a nervous system and breathed into arteries, veins and nerves alike the breath of life.

The ideal condition of things would be the complete annihilation of time and space and perfect freedom of transit within the limits of the planet, and it is towards this goal that the world is hastening. Under "free international transit," there would be no starvation, no congestion either of human beings or of their products anywhere. The questions of immigration and of emigration, of imports and exports, would settle themselves, for both men and their products would go forthwith where they were wanted. And to secure this ideal condition it is only necessary that public revenues and public machinery, now devoted to mutual injury, be devoted to mutual service. Would it not be a far cheaper and an infinitely more effectual method of preserving the peace and promoting the prosperity of nations for the different governments to build ocean ferry boats for the promotion of "free commerce" than to spend their revenues in building "commerce destroyers?"

Is this a mere dream? The dream of to-day may be the reality of to-morrow. But even if free international transit be in the dim distance, it does not follow that the free use of our great public services, the telegraph and telephone, the railway and tramway, within the limits of the nations, may not be near at hand. My scheme for the equalization of opportunities is to widen the sphere of the post-office so as to cover the whole business of public communication and transportation, to make "ordinary travel" and the ordinary use of the telegraph and telephone free, while, for special services, and for the transportation of property I would determine the transit tax on the postal principle making, at the outset, the lowest rate now charged for the shortest distance for any particular service the uniform standard rate for that class of service for all distances.

My paper is especially devoted to the consideration of "free travel," but it also treats, at considerable length, of the growing movement towards the grouping of railway stations with a uniform standard rate regardless of distance, and proves, I think, that the postal principle applied by Sir Rowland Hill, in 1839, to the transportation of letters, is equally applicable to the transportation of all other property and is indeed the natural law for the determination of all transportation taxes.

That the regulation of the movements of persons and property should never be left in private hands is to my mind a self-evident truth.

As to the advantages to be derived from "free travel" we have an admirable illustration in the case of the elevators, the vertical railways of our city office and apartment buildings. Would it not be a stupid thing for the owner of a New York tower to charge tolls for the transportation of persons and property between the different communities within his realm and would it not be infinitely more stupid to allow a stranger to build the vertical railway in his building and to levy just such tolls as he pleased? If it is good business for the owner of the tower to run his heavenly railway free of tolls and to support it by a general tax on the tower property, would it not be equally good business for our different communities to run our systems of earthly communication free of tolls and support them by the ordinary methods of taxation? It is only by "free ordinary travel" that we can secure to every man the widest possible opportunities to make the most of his life.

"Free travel" will effect a saving to the public in the use of our tramway system, of from $600 to $1,200 per car per year, or about 20 per cent of the entire cost of their operation *by dispensing with conductors*. The electric cars of Chemnitz, Saxony, run without conductors and with an annual saving of 44,000 marks ($11,000).

Free travel by ordinary public conveyance, however, does not imply that all travel should be free. My proposition is simply to change the relation of the classes. The testimony of the officers of the Boston and Maine Railroad proves that if you are only rich and powerful you can travel free to-day. The President of the Pennsylvania road says that the passengers in Pullman cars do not pay half the cost of their transportation and those who take their dinners on the cars do not pay a quarter of the cost of their dinners. This surely is contrary to common sense and to common

justice. Travelers in Pullman cars should not only pay the actual cost of their own carriage but should also contribute of their abundance for the support of the general traffic without which they could not enjoy their luxuries. But this does not necessarily involve any increase in the charges now made for special railway services. President Roberts' statements are true, I believe, only because the special rates are so high that comparatively few people can afford to avail themselves of the use of the special cars. It is not by increasing the transport taxes that Pullman cars are to be made a source of income or that freight business is to be made more profitable. On the other hand, it is by making rates low and uniform so that cars that now go empty may then go full, and that men and women now impoverished by prohibitive transportation tariffs may then be able to earn a comfortable living. The public interest demands that the mileage system of railway rates should be altogether abandoned and that in its stead (where the traffic is not free), we should adopt the life-giving postal principle making the rate now charged for the shortest distance for any particular service the uniform standard rate for that class of service for all distances.

This system of determining transportation taxes has long been in use on several of the great railway milk routes entering New York city, the rates being the same within distances of 200 miles and, says the Interstate Commerce Commission, "it has served the public well. It tends to promote consumption and to stimulate production. It is not apparent how any other method could be devised that would present results equally useful or more just. It is upon the whole the best system that could be devised for the general good of all engaged in the traffic." And the railway managers of the country seem to agree with the Interstate Commerce Commission, for the system of grouping stations with a uniform rate is rapidly growing. It is very common in the coal districts; the entire Hocking Valley, Ohio, is grouped. In the Delaware peninsula the rates on grain, flour and other similar products are the same for a large group of stations. All or nearly all the hundreds of stations in New England, south of Portland, Me., are included in the group, known as "Boston Points" from each of which the rates are the same on the same class of goods to all of the stations in even larger groups in the South and West. The rates on oranges are the same from Los Angeles, Cal., to all stations east of the Mississippi river, the same to Chicago 2265 miles and to New York 3180 miles. In Jan., 1894, the Canadian Pacific road commenced to sell passenger tickets at the same rates ($40 first class, and $30 second class), from St. Paul to Vancouver, 1660 miles, to Portland, 1990 miles and to San Francisco, 2760 miles.

The custom of giving large groups of stations a uniform rate on similar goods has indeed become almost universal in through railway business and, as I have shown, it is not uncommon in way traffic. Is it madness to propose the general grouping of all the railway stations in this country, making the lowest rate now charged for the shortest distance the uniform standard rate for all distances? So said the English conservatives in 1837

of Sir Rowland Hill's proposition to group all the postal stations in Great Britain with a uniform two-cent letter rate. His scheme was adopted none the less, and since then the same rate has been applied to all the group of post-offices in North America, while nearly all the post-offices of the civilized world have been brought into one group with a uniform rate of five cents. Several of the nations of Europe have also, in recent years, extended the sphere of the post-office to the transmission of parcels. one pound to eleven in weight, grouping practically all products in one class and including in one or two groups all their towns and villages. The Imperial Parcels Post of Germany carries parcels, up to eleven pounds, distances up to ten miles for 6¼ cents and for all greater distances within the empire for 12½ cents.

And now we find great railway corporations and groups of corporations giving to each of the stations in ever widening zones, the same uniform grouped rates, sometimes for persons, sometimes for property, almost universally in through business and not infrequently in local business. Is not the conclusion inevitable that so long as and so far as our systems of public transportation are supported by tolls, those tolls should be levied on the postal principle and should be determined by the government? It is along these lines, it seems to me, that we are to look for our future advancement.

[This paper will be printed in the Arena for December, 1895.]

A COTTAGE SETTLEMENT; "IN SPAIN." By MARY J. EASTMAN, 1905 N Street, Washington, D. C.

[ABSTRACT.]

REMARKS on the old subjective theory of charity as opposed by the modern objective theory, which tends to *constructive benevolence.*

Ignorance among the poor of the true art of living due largely to lack of acquaintance between the thrifty and the shiftless. It is desirable to bring these two classes into communication in order that the ignorant may profit by the experimental knowledge of the more prosperous working class.

To this end is directed the Cottage Settlement which aims to utilize the help of the more capable women of the middle and working class, to instruct in ways and means their less prosperous fellows. This question bears radically on the subject of the dislocation of domestic service.

The development of the subject touches incidentally the true solidarity of classes in the community and the possibility of exhibiting and maintaining a standard of thrift and comfort unknown and, largely because unknown, unattempted among the poorest inhabitants of our large cities.

A SYSTEM OF CO-METALLISM. By I. W. SYLVESTER, Passaic, N. J.

[ABSTRACT.]

THIS paper outlines a new and somewhat novel system of coinage, amounting in effect to the union of both metals in all coins and in all metallic payments. It is claimed this would prevent the demonetization of either metal, secure their proper valuation by the public and do away with the embarrassing effects of a varying commercial ratio.

No government fixes the value of its coins; their value can be estimated only by the transactions in which men exchange products or some form of property for them. The injury done to silver by decreeing that it shall not be freely coined is found in the fact that unless it is freely coined people will not be compelled to receive it in exchange, and therefore are not compelled to value it. Gold is to-day freely coined in any amount that may be offered; merchants by virtue of the legal tender law must receive it in exchange for their commodities and therefore must value it. To secure the same valuation for silver, without demonetization or other commercial injury, a plan of co-metallism is proposed.

While it is possible to evolve a system without bringing into actual existence the unit of value, it is yet desirable to have it coined, provided it be of convenient size and weight; for then it both serves the purposes of trade and becomes an object lesson of greater or less value to every person. Therefore the present proposition is that the dollar, or unit of value of the United States, consist of a disc of standard gold, weighing 12.9 grains, of the circumference of our present fifty cent piece, mechanically united to a disc of standard silver, weighing 206.25 grains, similar in diameter and circumference, but necessarily much thicker. This dollar would then be substantially of the size of our silver fifty cent piece; one side of it would present an entire silver front, and the reverse side would present an entire gold front. It would be very handsome, and as to size and weight it would be very convenient; any one would be able to carry on his person, without inconvenience to himself, double to treble the number of metallic dollars that he can do at present. It could not be counterfeited with any greater ease than our present metallic money; and while I can find in my own mental searchings no valid objections to the coinage of such a legal tender dollar, I do see on the affirmative side many desirable influences which would spring from its existence.

A *co-metallic coin bar*.—But I would not stop with the creation of this co-metallic dollar; it should be supplemented with a $500 co-metallic coin bar, the creation of which, with or without multiples, would make the system complete, and greatly promote the public convenience. This coin bar can readily be manufactured by mechanically pinning a slab or bar of standard gold of the proper weight to a much thicker and somewhat larger slab or bar of standard silver of the proper weight. Bars of pure gold and bars of pure silver are now made at our assay offices and mints, greatly varying in size, weight and value. The ordinary sized silver bars now made at the New York Ass y Office weigh something over

200 ounces, and they are considered a convenient size for handling and transfer in the bullion markets. The sizes vary more or less in thickness, but 7.5 by 3.5 by 1.5 inches is a common size. Now a bar similar in size say 7 by 4 by 1.5 inches could be cast from standard metal, the weight of which would just equal the number of grains in $250 (412.5 grains to the dollar); 250 whole dollars equal 500 half dollars, and if we insert on one of the faces of this silver bar—in the language of carpenters countersink it —a bar of standard gold so adjusted in weight as to equal the number of grains in 250 gold dollars, we have by the union of these two bars 500 co-metallic dollars. The silver bar might be so cast as to have a recess of the proper dimensions formed on one of its faces; and into this recess the gold bar might subsequently be placed. The gold should be made to occupy a plane surface level with the silver surface, 2 by 5 inches. In this way the edges of the gold bar would be protected by the silver bar from abrasion and the gold surface would occupy 10 square inches in the center of the bar's face. The gold bar would approximate $\frac{1}{16}$ of an inch in thickness, and the recess in the silver bar would be of the same depth. The gold bar may by any practical method be made to present a smooth surface even with the silver, and to fit snugly the recess. To hold the bars together a countersunk steel screw bolt should be run through two corresponding holes at the center of each bar; this screw bolt should screw upon itself and be so adjusted as to hold the bars firmly together, at the same time enabling one suspicious of counterfeiting to take the bars apart for examination, and to put them together again without wearing away any of the precious metals. Upon the face of this co-metallic bar any simple and appropriate design may be placed; but the figures and letters expressing its value should be stamped partly on the gold surface and partly on the silver surface, so that they would be divided and meaningless in case of any separation of the two metallic bars. The manner in which this may be done was shown in the cut. The weight and fineness of each bar and the American eagle could be stamped on each bar at any appropriate place or places. There would thus be a union of two bars, not so strongly united as to prevent inspection and examination at any time that these might be desired in guarding against counterfeiters, but strong enough to make it practically one bar; or, as I have named it, a co-metallic coin bar.

Such a coin bar would be, in my judgment, a great convenience in effecting large payments. Its size and weight would permit of its being readily handled, and its form would favor packing in boxes and storage. Multiples of the dollar, and both multiples and subdivisions of the coin bars might be made by carrying out the principles more minutely; but the one dollar co-metallic coin described, and the 500 dollar coin bar described, would in and of themselves, constitute all that is necessary in the way of coinage to adapt this system to the needs of commerce.

Both the coins and the bars would pass from hand to hand, and in this way would become familiar to the people; but, in addition, the creation of the coin bars naturally suggests their use as deposits against an issue of

bills, or paper certificates of deposit. Both the government and our banks should be authorized to receive them and to issue fractional certificates of deposit against them; the coin bars to be held in trust for the redemption of the bills. We should then have a monetary system based on the total volume of gold and silver combined. It would be a system in which neither metal by variations of market value could drive the other out of circulation, for there would be but one kind of metallic dollars—but one unit of value; and the value of this unit would be the merchandise value of its gold plus the merchandise value of its silver, plus the value of its legal tender attribute. And last, but by no means least in importance, we should have the best paper money in the world; that is, a paper money secured by an actual deposit of gold and silver held in trust for its redemption at any time that certificates might be presented.

The concluding portion of the paper dealt with co-metallism as distinguished from bi-metallism; coinage and its objects; the ratio; elasticity and volume of currency. The author opposed bi-metallism and affirmed the impossibility of the government's ability to keep gold and silver at any constant ratio. It was in his view not only an impossibility, but undesirable, and would prove disastrous if the attempt were made. It was far better to employ the ingenuity and skill which is at the present time so marked a feature of our civilization, in devising a system whereby the attempt becomes wholly unnecessary and useless.

The effort was to take advantage of modern methods and skill, in such a way as to enlarge the usefulness of both metals; reconcile hostile opinions, and facilitate the exchanges of commerce.

GROWTH OF POPULATION OF GREAT CITIES. By ELMER LAWRENCE CORTHELL, D.Sc., 71 Broadway, New York, N. Y.

IN 1886 and 1887 Mr. Rudolph Hering, civil engineer, and at that time Chairman of a Commission for solving the problem of water supply and drainage of the city of Chicago, compiled some statistics and made a diagram showing the curve of growth of population of several cities in the United States. About the year 1890, for the purpose of presenting in a professional report on a rapid transit question in Chicago a comparison between the several cities shown on Mr. Hering's diagram, the writer extended the diagram to a more recent date. During the last year he has, by an extended correspondence, obtained the necessary information and has plotted on a new diagram the curves of growth of population of several cities of the world numbering over 1,000,000 inhabitants at the present time. These curves have been extended both backward and forward as will be seen by an examination of the diagram. Many interesting and instructive features are presented by this comparison, and the value of the results thus presented graphically will be at once appreciated by an examination of the diagram.

The editor of London Engineering (to which this paper is primarily contributed, and by which it is now being published), suggested to the writer during the investigations that it would be still further instructive,

and interesting as well, to ascertain and give graphically the comparison of density of population. This has been done as far as it is possible to obtain the information. The squares showing these densities are from the latest census in each case and may be considered the present density.

The information has been obtained from official sources through the following correspondents, all of whom kindly interested themselves to comply with the author's requests for data, and to whom he is largely indebted for the reliable character of the figures:—

Mr. James Forrest, Secy. Institution C. E., London, England; Mr. C. O. Gleim, C. E., Corresponding Member Am. Soc. C. E., Hamburg, Germany; Mr. Ernest Pontzen, C. E., also Corresponding Member Am. Soc. C. E., Paris, France; Hon. Clifton R. Breckenridge, U. S. Minister to Russia and Lieut. Henry I. Allen, Naval Attaché, U. S. Legation, St. Petersburg, Russia; Hon. Chas. Denby, U. S. Minister to China, Pekin; Mr. John C. Trautwine and others in the United States.

As each city has its peculiarities in history, growth, density and many other features, it is necessary to take up each separately, in order that the reader may fully understand and appreciate the curves on the diagrams.

LONDON.

For the information of our readers who are not familiar with the peculiar geographical conditions of the population, the following data need to be given in order to have a full understanding of the subject.

London within various boundaries:	Area in statute acres.
Within the registrar-general's tables of mortality	74,672
Within the limits of the county of London	75,442
London school board district	75,442
City of London within the municipal and parliamentary limits	671
Central criminal court district	269,140
Metropolitan parliamentary boroughs (exclusive of the city of London)	74,771
Same (including the city of London)	85,442
Metropolitan police district (not including city of London)	442,750
Metropolitan and city police districts	443,421

The metropolitan police district extends over a radius of fifteen miles from Charing Cross—688.31 square miles, exclusive of the "city of London."

The population used in the curve of growth is that included in the registrar-general's area. It is almost impossible in the case of London, as well as that of other cities, to define the area of the metropolitan population, that is, the population of the city itself and of the suburban districts which contain the population doing business in the city. The limits of London could be extended far beyond those of the registrar-general, and with each extension a much different population would be found to exist. To compare perhaps more favorably with the other cities and cover the metropolitan area, it seems proper to state that the population supplied

by the London water companies in 1892 was estimated to be 5,490,780 and this population is plotted on the diagram. In 1891 the population of "Greater London," if we include the "outer ring," was 5,633,806.

As to density of population, that of the White Chapel district is taken as a maximum, being on the 357 acres included, at the rate of 132,000 per square mile. The average in the whole of London is 37,000 per square mile.

NEW YORK.

The curve of growth of this great city of the United States is interesting, first, by its comparison with its neighbor Philadelphia. The curves show that they kept pace with each other very closely from the year 1700 to 1830, when population in New York began to grow with rapid strides and has continued to do so up to the present time, the ratio of increase being greater than that of any other large city in the world except Chicago and Berlin. The density of the tenth ward, which is on the east side of the city between the Brooklyn Bridge and Grand street, is greatest of any in the world, with the exception perhaps of a certain district in the city of Prague, and it may be said advisedly that Sanitary District A of the eleventh ward has the greatest density of any corresponding area of the world, and twice that of Prague in 1893. It comprises about 320 acres and the density ranges from 600 to 1000 inhabitants per acre, or an average of about 512,000 per square mile; the greatest density being 640,000 per square mile.

PARIS.

In 1860 the area of Paris was considerably extended by taking in the suburban communes, which increased the population at that time nearly half a million. The density of the population is shown, first, by taking out the squares, or greens and woods, making the average on this basis 121,300 per square mile and the area 22.4 square miles. The average of the entire city including the squares, etc., is 79,500 per square mile, covering thirty-one square miles. The curve of growth of Paris brings out several interesting and important historical points. For instance, the city, as is well known, suffered greatly during the latter part of the reign of Louis XVI and during the reign of terror, from 1774 to 1799, during which period the population actually decreased. On the other hand, under the reign of Louis XIV, 1643 to 1715, and that of Louis XV, 1715 to 1754, it greatly prospered and the growth in the latter period is shown on the curve as having a regular increase. From 1852 to 1870 the Emperor Louis Napoleon did much for Paris and its growth was very rapid and comparatively uniform. The effect upon the city by the Franco-Prussian war and the Communes is shown plainly on the curve of growth.

CHICAGO.

This city, on account of its large area in comparison with the population, has an average of only 6,430 inhabitants to the square mile, its area being 186 square miles. In arriving at the population for 1894, it is necessary to use considerable judgment in deciding which census should be employed.

There have been estimates made of over 2,000,000, but to be conservative the school census of 1894 is used, making the population, including the whole of Cook County 1,692,727. In ascertaining the ratio of increase, different results are obtained by using different methods of estimating the population, whether by the United States census or by that of the city. The increase from 1880 to 1890 by the United States census was 118 per cent. Comparing the United States census of 1890 with the school census of 1890 the ratio of increase per decade is 106 per cent. If, again, we compare the school census of 1884 with the school census of 1894 we have an increase of 150 per cent per decade.

BERLIN.

The census of this city is taken every year and has been so taken since the year 1720. Consequently the curve of growth is an entirely different one from that of almost any other city, as the points in drawing the curve are much nearer together on the diagram. As in the city of Paris diagram so in that of Berlin the effects of political and military disturbance in the kingdom are plainly seen. The seven years war from 1756 to 1763 caused a *decrease* in the population. From 1800 to 1810, an entire decade, there is again a steady decrease and it was during this period that the battles of Hohenlinden, Jena, Auerstadt, Eylau and Friedland were fought with the French. By the peace of Tilsit at the end of this period Prussia lost one-half of her possessions and kept the other half under very hard conditions. In 1871 the King of Prussia was proclaimed Emperor of Germany and Berlin became the seat of the empire. From that time to the present the growth has been very rapid, the ratio of increase from 1883 to 1893 being 37 per cent.

In density Berlin stands next to Paris, the maximum density being 92,600 per square mile and the average density 67,612, with an area of 24.3 square miles.

VIENNA.

The accessible records of population of this city are very incomplete and the curve of population is made from a comparatively few dates. The authorities differ considerably as to the population. The fact that the garrison of the city is constantly changing vitiates the census records.

PHILADELPHIA.

There is nothing particularly striking in regard to the curve of this city. It shows a gradual growth and very regular. The density of population is very nearly like that of Chicago, being 8091 per square mile on an area of 129 square miles.

ST. PETERSBURG.

The effect of the founder, Peter the Great, upon the inception of this city and its growth during two decades is plainly seen at the origin of the curve. In fact it is generally known that, when it was founded in 1703, compulsory means were employed to increase the population to 100,000,

during his reign. Under Elizabeth, from 1741 to 1762, it reached 150,000, and under Catherine II, 1762 to 1796, it reached nearly 300,000. One disturbing feature exists in the census estimates, in that the city has a much larger population in the winter than in the summer, as is well known. The curve of growth includes this winter population and also the immediate suburbs, the object being to arrive at the metropolitan population. In reference to the density of population the most thickly settled ward has 50,000 inhabitants, or at the rate of 113,636 per square mile, and the most thickly settled district in that ward has a population of 227,276 per square mile. The average for the whole city on an area of 350 square miles is at the rate of 28,260 per square mile.

PEKIN.

The census records of the population of this city are so meagre that it has been found impossible to get sufficient data for plotting the curve. The population has *decreased* regularly since 1797 and is now probably rather less than 1,000,000. Including the immediate suburbs the area of the city is about twenty-seven square miles.

Recapitulating the statements in regard to ratio of increase at present in the several cities above noted the following summary is given:—

Present ratio of increase,	London,	10.4 per cent.
" " " "	Greater London,	18.0 " "
" " " "	New York,	33.3 " "
" " " "	Paris,	10.0 " " last decade.
" " " "	Paris average last three decades,	12.7 per cent.
" " " "	Chicago,	106.5 " "
" " " "	Berlin,	37.0 " "
" " " "	Philadelphia,	25.0 " "
" " " "	St. Petersburg,	15.0 " "

As the number of houses and the number of inhabitants per house have much to do with the density of population the following items are of considerable interest:—New York has 150,000 houses averaging eighteen residents. London has 600,000 houses averaging seven residents; at the beginning of this century it had only 130,000 houses. Paris has 90,000 houses; at the close of the Franco-Prussian war it had 70,000, and at the close of the Napoleonic wars it had only 23,000. The average number of residents in a Paris house is twenty-five, forty per cent greater than in New York. The most of the public and office buildings in Paris are utilized for residence purposes, whereas in New York most of the buildings in the down town district are used entirely for business purposes. Taking a square mile of territory between Wall and Spruce streets and between Broadway and the East River there was at a recent election only 430 voters, representing a total population of about 1750. The unoccupied

spaces in parks, gardens and lawns in Philadelphia is seen from the fact that while its population is only about 1,000,000 it has 187,000 houses.

The facts on the diagram offer material for interesting study; such as the influence of national life upon urban growth, especially upon that of these principal cities; the serious effect of war upon the growth of cities; the remarkable change going on in these countries by which the great cities are pushing upward their curves of growth; and, what is perhaps of greater interest still, the quite close approximation that it is possible to make of the time when some of the curves will intersect and the rank in population be changed, some outstripping others and some falling behind their more prosperous competitors.

An approximate estimate may at least be hazarded, predicting the population of the cities under consideration at the end of future decades.

Certain important possible changes in conditions need however to be considered in forecasting such results, among which are, first, the changes which new methods of transportation may bring about, either taking people more quickly and cheaply into cities, or out of them into more distant districts now open areas or sparsely settled country. Second, the congestion or overcrowding of city areas making them too dense for comfort or health. These two conditions are already producing changes of magnitude in population. London is an instance of these effects or of some others possibly; several of the central districts instead of showing an increase showed actual decrease in the last two census epochs.

It is difficult to predict now what change will take place in New York during the succeeding decades by the contemplated transportation changes; such as the opening of the bridge over the East River at Blackwell's Island, the new East River Bridge at Grand street, the construction of one of the chartered bridges over the North River and probably the completion of the tunnel, the expenditure of perhaps $60,000,000 in new rapid transit facilities, the substitution of electric locomotives and trolley lines for the present railroad locomotives, perhaps even the introduction of high-speed bicycle trains, etc., etc.

As to Chicago, which is the phenomenal city of the world in respect to rapidity of growth, it may be safely assumed that its ratio of growth will continue with no great diminution for two decades at least to come. Precedent, or the history rather of great cities, goes to show this, and then its remarkably advantageous position commercially gives additional reason for this belief.

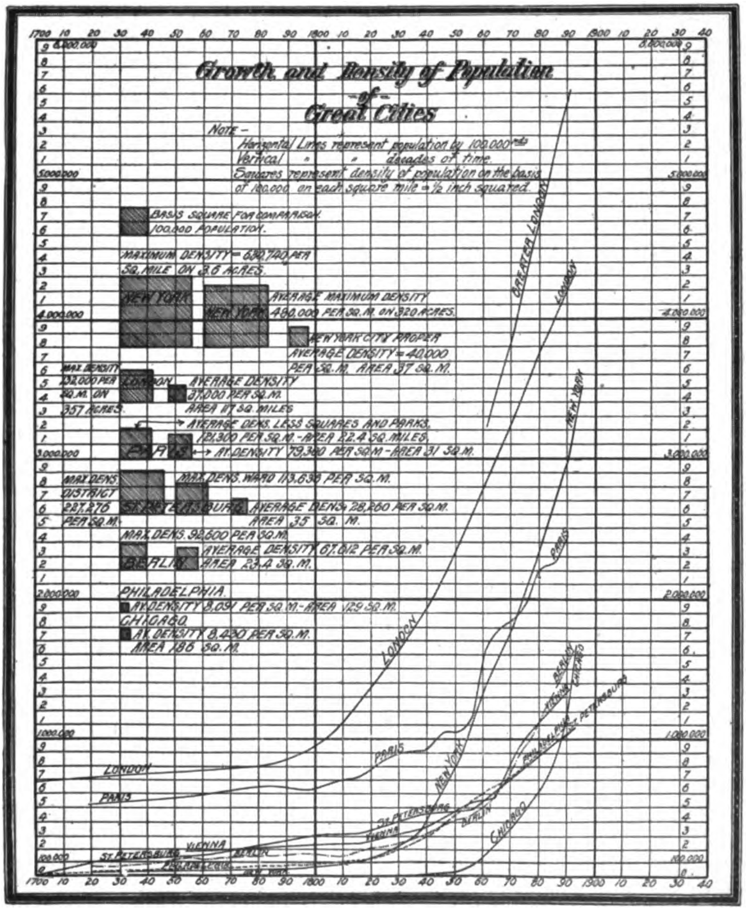
Berlin may also be expected to grow with great rapidity for at least two decades more. As the seat of a new empire, it is still young, strong, vigorous and ambitious.

And in addition to all other reasons for the continuance in rapid growth of the above mentioned cities there must be taken into account that of the modern tendency to gravitate to great centers of population which modern methods of transportation have accelerated.

Even with the above problematic conditions disturbing the future there is sufficient ground on which to rest a prediction of population, which the author has the temerity to make as follows :—

FORECAST OF POPULATION.

City	Estimated population in 1900	Estimated population in 1910	Estimated population in 1920
Greater London,	6,496,000	7,490,400	8,516,256
London,	4,599,800	4,967,784	5,315,528
New York,	3,900,000	4,953,000	6,191,250
Paris,	2,697,300	2,967,030	3,234,063
Berlin,	2,101,400	2,731,820	3,496,729
Chicago,	2,400,000	4,560,000	8,208,000
Philadelphia,	1,414,500	1,697,400	2,002,932
St. Petersburg,	1,185,600	1,339,728	1,500,495



MANUAL TRAINING IN HORTICULTURE FOR OUR COUNTRY SCHOOLS. By Prof. WILLIAM R. LAZENBY, Columbus, Ohio.

[ABSTRACT.]

MANUAL, or industrial training, is fast becoming a popular adjunct to our city schools and is helping to solve the problem of what to do with the city boy. If something similar was introduced into our country schools it would be equally helpful in solving the problem of what to do with the boy and girl in the country.

Our country schools are being graded and in many rural townships high schools have been established. Here is the place for the introduction of manual training in horticulture. The land needed for this purpose could be easily secured and the necessary tools and appliances would be comparatively inexpensive. The cultivation of flowers, of ornamental trees and shrubs, a miniature model kitchen or vegetable garden, and plantations of small fruits, could be easily undertaken.

The operation of propagating plants by seeds, cuttings, budding, grafting, etc., the collecting and planting of weeds, the breeding of the more common injurious insects, and the application of some of the best remedies, a thorough practical acquaintance with our native forest trees and shrubs,—all this could be readily taught and practised in our country schools. Such teaching could not fail to arouse interest and develop a taste for scientific thought and investigation.

In addition to the direct practical value of such training it would cultivate the pupils' æsthetic faculties and develop an appreciation of the beautiful in nature and in art.

It would mean an improvement of our school-house grounds, and the proper adornment of these would tend to elevate and sweeten the whole community.

If we have beautiful school buildings with beautiful surroundings the inference is inevitable that we shall have refined, noble teachers. Take a view of the immediate external surroundings of the homes in any neighborhood; to the observing eye, does not each little plot of ground about the house tell much of the characteristics of those who dwell therein? Here, we see good taste and order; there, vulgarity and disorder. Here, mathematical precision; there, chaos and confusion. Here, you see evidences of much labor, but all misdirected, without skill or knowledge; again, you see evidences of taste but too much was attempted and the lack of time and means results in failure. Here you see a profusion of trees, shrubs and flower-beds, without any design, a mixed nursery and not a landscape. There we have neither trees, nor shrubs nor flowers, and the house looks naked and desolate. Every phase of human character is shown; we have a reflected portrait, a sort of mental photograph in the grounds about every house of the family that occupy it.

It may be said that shop work as a form of manual training in our country schools is more practical, because more in demand, than horticulture. But is this true? While horticulture is one of the youngest it is one of the most rapidly developing arts in this country.

The fruit interests alone of states like California, New York, Ohio, Michigan and others, are great and constantly growing. The forcing of winter vegetables and the cultivation of the finer products of the kitchen garden are rapidly extending and becoming more and more profitable. Commercial floriculture is developing with marvelous rapidity, and a general home interest in flowers and ornamental gardening has broadened. By a broad and liberal interpretation, horticulture embraces many divisions and in each of these there is a growing demand for instruction and training. At what place can this demand be so well met as in our country schools? The subject should be thoroughly agitated and brought before the attention of every rural community. It appeals to every practical man. Horticulture, in its divisions and by its methods, furnishes technical training, useful knowledge, and intellectual culture.

Should you say there is no time for such training, then time should be made for it. There are few country schools where something could not well be omitted or postponed in favor of this. To train the eye and hand, to stimulate the power of observation, to awaken an appreciation of the beautiful, in short to develop all the faculties of body and mind is the aim of modern education. What better than manual training in horticulture can aid in securing this end?

AN INTERNATIONAL COINAGE. By HENRY FARQUHAR, Asst. Statistician, Dept. of Agriculture, Washington, D. C.

[ABSTRACT.]

EXAMINATION of arguments opposing and favoring the coinage of pieces to be current in more than one country: (1) The fact of the trial and failure of such a system in the middle ages; (2) The facilitation of commerce and avoidance of inconvenience, delay and fraud to travellers. Why any adopted coinage should be based on the French system of weights. Relations of a proposed unit, of nine grammes of fine gold, to various coinages now prevailing: precisely 31 francs or lire, almost precisely 7½ roubles, and nearly 6 dollars ($5.98), or ten British half-crowns (295^d 9⅝ h. c), or 25 German marks (25.11), or 30 Austrian crowns (29.52), or 15 Netherland guilders (14.88).

THE LAW OF CHANCE ILLUSTRATED IN RAILWAY ACCIDENTS. By Prof. T. C. MENDENHALL, Worcester, Mass.

ON SUICIDE; BEING A PAPER ON RECENT STATUTE LAW, AND CASE LAW, OR JUDGE-MADE LAW ON SUICIDE, WITH STATISTICS, ETC. By W. LANE O'NEILL, LL.D., World Building, New York, N. Y.

EXECUTIVE PROCEEDINGS.

REPORT OF THE GENERAL SECRETARY.

THE FORTY-FOURTH MEETING of the American Association for the Advancement of Science was called to order in General Session, on Thursday, August 29, 1895, at 10 A.M., in the Young Men's Christian Association Hall, Springfield, Mass., by Prof. F. W. PUTNAM, the Permanent Secretary of the Association. Professor Putnam read the following letter from the retiring President:—

ROTTERDAM, HOLLAND, Aug. 14, 1895.

DEAR PROFESSOR PUTNAM:—

After waiting until after the last date which would bring me back in time for the meeting of the Association, before deciding about it, I find myself obliged to remain on this side. My wife's health is not sufficiently improved for her to return, and with many regrets, I shall have to forego the honor of reading my Address before the Association, and the pleasure of joining in the discussions of Section H.

I shall feel under many obligations in addition to those I already owe you, which are numerous, if you will have some one read the address for me, and explain to the members the cause of my absence.

I heartily wish for the Association a successful meeting, and sincerely regret that I shall not be there to perform my share of the duties connected with it.

Very cordially yours,

D. G. BRINTON.

After announcing that the Address of President BRINTON would be read at the evening session by the GENERAL SECRETARY, the PERMANENT SECRETARY called Prof. WM. H. BREWER, of New Haven, the Senior Vice President, to the chair.

Professor BREWER then introduced the President-elect, Prof. E. W. MORLEY, of Cleveland, in the following words:—

Ladies and Gentlemen:—It is a custom of this Association that the retiring President introduce the in-coming President at the opening of the first public session. The letter just read by the Secretary explains the absence of President Brinton and why the duty devolves upon me. My function here is a very simple one. But for the painful cause of my

being called to perform it, it would be a very pleasant one. Except for the requirements of formality, the new President needs no introduction to the members of the Association. All are familiar with his published works, and his person is familiar to all the older members by his presence at these meetings for more than a quarter of a century.

But those in the audience, not professionally engaged in scientific work, may not be familiar with the reasons why he has been thus honored. Our new President is probably most widely known to the scientific men of the world because of his masterly investigation of the chemical composition of the atmosphere, a matter of interest to every creature that breathes. Analyses of air have been made from the earliest days of chemical science, but all the earlier ones were made under the older and cruder methods, and in comparatively limited numbers. They might be reckoned perhaps by the score, but his are to be reckoned by the thousands. They were performed in accordance with methods devised by him, were continued day after day, month after month, year after year, in every state of the weather and under every condition of temperature and barometric pressure. The ingenuity with which the methods were devised, the scientific accuracy with which the analyses were performed, the diligent patience with which the work was conducted under many difficulties, the untiring zeal with which they were continued for so many years, were calculated to inspire the confidence of scientific men and awaken the admiration of the thinking public. It therefore gives me pleasure to introduce to you, as President, to preside at the sessions during our meeting here, Prof. Edward W. Morley.

President Morley thereupon took the chair and called upon the Rev. Bradley Gilman, Pastor of the Church of the Unity, to invoke the Divine Blessing upon the Association.

After the invocation President Morley introduced ex-Lieutenant Governor William H. Haile, President of the Local Committee, who delivered the following address of welcome: —

I have been delegated by the local committee of arrangements to extend to the members of this Association, who are here with their kindred and friends, a most cordial welcome to our "city of homes." I may be pardoned for calling your attention to the fact that the birth of Springfield was practically contemporaneous with the beginning of the history of the old Bay State. It is related that once upon a time a member of the First church of this city was boasting of its antiquity to a friend. Said he, "Our church was organized in 1637." His friend replied: "You must be entirely mistaken in your date, for the Pilgrim fathers did not come to this country till 1620." "That is very true," said the other, "but they started for Springfield as soon as they landed."

It seems to us that in the contemplation and discussion of the scientific problems which will engross your attention, no more suitable place could be found than our Connecticut river valley, with its historical associations, its environment of many institutions of learning and its great

variety of industries. That your convention will be a success we trust and believe confidently. That its result will have a beneficial effect upon this community we know in advance. This is an age which is demanding the fullest exposition and explanation of the wonderful phenomena, hitherto so entirely hidden in obscurity, that science is bringing to light. What a vast amount an all-wise providence has in store for us, which will in due time be made plain to humanity! and it is the privilege of this Association, which embraces in its members so many who have achieved marked success in the realm of science, greatly to advance the cause of scientific research and knowledge.

It has been the endeavor of the local committee so to arrange for the series of meetings you will hold as best to subserve the convenience of the Association. The various buildings and halls you will occupy have been most cheerfully placed at your disposal. An opportunity will be afforded you to visit some of our neighboring cities and towns, the result of which we doubt not will be found interesting and instructive. Arrangements for social entertainments have been planned.

We trust that your stay with us will be very enjoyable and as you leave our city, having made observation of its splendid location, its beautiful park, its public buildings, its homelike residences, and its various industries, its wide-awake and progressive citizens believe that you will have come to the conclusion that Springfield is a city which possesses the elements of success and has before it bright promise for growth and prosperity. We also trust you will hereafter look back upon this convention as one of great interest and profit to your Association.

President MORLEY then introduced The Honorable CHARLES L. LONG, Mayor of Springfield, who was received with great applause and delivered the following address of welcome:—

MEMBERS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

LADIES AND GENTLEMEN:

More than a third of a century has passed away since this Association last met in this city, on the third day of August, 1859, for the purpose of holding its thirteenth convention. Prof. Stephen Alexander, that distinguished astronomer whose writings attracted the attention of scientific scholars of this country and of other lands, presided at the meeting.

The political and scientific changes which have taken place during the period that has passed have been many; and they have been as remarkable as they have been numerous.

When that convention assembled, human slavery was a legalized institution in the Southern States, and the great question of its extension into the territories, and of their admission into the Union cursed with its blight, agitated the people. Two months had scarcely passed after the convention adjourned, before the country was convulsed with excitement over the insurrection at Harper's Ferry, and within two years the storm, which had

for so long been gathering and which was to settle forever the great question of state rights and human slavery in this country, broke with terrific fury upon our beloved land, drenching it in fraternal bloodshed in a conflict unequalled in its magnitude and unsurpassed in the importance of the results achieved.

No doubt the learned men who assembled at that convention were proud of the success which had thus far crowned scientific investigation, and gloried in the great advance which had been made. But so great have been the discoveries which have followed, and so wonderful have been the changes which these discoveries have wrought, that we can hardly appreciate that many of the great scientific truths of to-day were but cautiously advanced theories at that time.

It was during the year preceding that convention that the paper of Wallace "On the tendency of varieties to depart indefinitely from the original type" and Darwin's paper "On the tendencies of species to form varieties," were read, simultaneously, before the Linnæan Society. On the first of October following that convention, Darwin published his "Origin of Species," which more than a decade later caused the French Academy to reject him as a candidate for membership by a vote of more than two-thirds, one of its members declaring that the "Origin of Species" was a mass of assertions and absolutely gratuitous hypotheses, often evidently fallacious."

Truly, "the stone which the builders refused is become the headstone of the corner," for the doctrines of Darwin's work are now recognized and accepted by the learned and scientific of the civilized world; and evolution, which was for years scorned and rejected not only by the great majority of the scientific, but by pretty much everybody whose views upon the subject were entitled to weight, is now universally accepted.

During this period the doctrine of spontaneous generation received the aggressive attention of scientists. The views of the learned Pasteur, which were opposed to this doctrine, were contested and were supposed to have been refuted by the experiments of Wyman. The theory of spontaneous generation is no longer accepted, but out of the agitation which it created, was born the new science of Bacteriology.

Indeed, during the period of which I am speaking, the progress in geological, zoölogical, physiological and astronomical science, in chemistry and in physics, has been marvellous. The wonderful development and utilization of electric forces, which forms such a marked demonstration of the value of scientific research, was not then dreamed of. Even the Atlantic cable had not been successfully laid, and the results of the wonderful inventions of Edison, of Bell and of many others of the great discoverers and inventors of the electrical world, were not, for a moment, contemplated.

The doctrine of the antiquity of man, which sought to place and which now places his origin far back beyond the period of six thousand years, which was then zealously contested, is now not only adopted by scientists but is swallowed complacently by all the well informed without any shock to their religious feelings.

These great advances, which have entertained, enlightened and improved the mind, and added greatly to the comfort, happiness and welfare of mankind, are the result of investigation and study by men such as those of you whose lives are devoted to scientific research and who are here assembled as an Association under a constitution proclaiming its object to be: "By periodic and migratory meetings, to promote intercourse between those who are cultivating science in different parts of America, to give a stronger and more general impulse and more systematic direction to scientific research, and to procure for the labors of scientific men, increased facilities and a wider usefulness."

You have assembled in a city which has sprung from one of the earliest settlements in this commonwealth. Here, two hundred and sixty years ago, the rude cabins of the first white settlers were erected. Here our Puritan ancestors found in large numbers, contented and happy in their savage freedom and ignorance, the American Indian, from whom they obtained by purchase the land upon which our city is built and with whom, for a period of forty years, they lived in uninterrupted peace.

Here, as declared in the first of the articles adopted for their future government, they laid the foundation of their future growth and prosperity in the principles of the Christian religion; and here, as a result of those principles, the industry and honesty of our predecessors and the aggressive qualities of our people, we have, to-day, a well governed, a prosperous and beautiful city, surrounded by natural scenery which excites the admiration of all lovers of nature; a city which, in population, in trade and in its industries, is deservedly recognized as the metropolis of Western Massachusetts.

I am greatly honored in being the representative of such a city, and as its representative in extending to you a cordial welcome to our borders, to an association with our people, to an examination of our institutions and to such entertainment as we may be able to provide for you; and I assure you that by your presence our citizens appreciate that they are greatly honored by reason of your high standing as individuals, your professional attainments, and the reputation of your Association, whose illustrious work in the past, will be, I am sure, excelled by the results which will crown its labors in the future.

Replying to the honorable gentlemen who had welcomed the Association President MORLEY said:—

GENTLEMEN:—

That which you say to us of the beauty of Springfield and of the scenery of this fertile valley commands our cordial assent. We listen with delight to the survey of the general progress of science since our last meeting in your city, which you state with so much fairness, and with so much justice and so much breadth of view. But the best of all are the words of hearty and generous welcome which are so grateful to us, because they assure us of a profitable meeting, and promise us delightful intercourse with your citizens.

Massachusetts is the last place on the face of the earth where this Association could possibly be made to feel like a stranger and an alien. It was an act of your legislature which incorporated us. Of our forty-two Presidents, Massachusetts can fairly claim as her citizens not less than seven, or one-sixth of the whole number. Almost from time immemorial one Permanent Secretary after another has been elected from Massachusetts. We have met at Cambridge, at Springfield, at Salem, at Boston and again at Springfield.

Let me interrupt for a moment my reply to your welcome. Some of us, for whom the backward view covers the larger part of the visible heavens, would recall something of our meeting here in 1859. There are now on our list the names of twenty-one who were members of our Association at that time. Its President was that Professor Alexander, of whom the Honorable Mayor of this City has already spoken. The Vice President (there was but one) was a most distinguished citizen of Massachusetts, who was the first President of the Society which was the parent of our own, known all over the world for his masterly labors in geology, Dr. Edward Hitchcock of Amherst. The General Secretary and the Permanent Secretary were Professors William Chauvenet of St. Louis and Joseph Lovering of Cambridge.

Of those who became members of this Association at our Springfield meeting, eighteen have maintained their membership to the present time or to their decease. But four of these are living. Professor G. F. Barker is known to us all; some of us think his compendium of physics is the best in the English language. Dr. Samuel H. Scudder is known for his work on the bibliography of science, and for his many labors in entomology: this Association has published a memoir of his on fossil butterflies. Professor Henry A. Ward is again here, making an exhibit of mineralogical and geological specimens which is a source of much pleasure to many of our own number and of the public. Of those whom we have lost I may mention Henry B. Nason of Troy, Lewis M. Rutherford of New York, and James Craig Watson of Ann Arbor.

The number of our members in attendance at that meeting was large; we may be sure that when such officers presided and such men became members, the meeting cannot but have been a successful and profitable one.

Gentlemen:—Your welcome was especially grateful to us, because it exhibited an appreciative interest in us and in our work. Such an appreciative interest has been exhibited in other ways. On eight days during the summer I have been where I read a Springfield morning paper. Four of these papers contained articles, of at least half a column, written with dignity, with adequate information, not without literary graces of style, which were devoted to this Association; therefore, in the judgment of a practised editor, many of those who read your daily papers have some intelligent interest in our Association, its history, its object, its methods, in the history of our sister associations in other countries.

Your words of welcome express the same appreciative interest, they

confirm the favorable impression we have received, and fill us with pleasurable anticipations.

We know something of Massachusetts, and of what sort of welcome we might reasonably expect. We know of Massachusetts, though not many of us are its citizens or its children. In the intention of its founders, our Association includes the whole of this continent; in accomplished fact our membership represents perhaps every state of this union and every province of the great dominion to the north of us, and a few from countries or islands to the south of us. Many of us have, therefore, grown up under other influences than those of Massachusetts. We come from other strains of colonization. We owe allegiance to other local institutions. We have learned to revere other local traditions.

But we all cordially agree in saying that, in all those things in which the citizens of a commonwealth ought to feel the highest pride, Massachusetts is unsurpassed. No contributions to political thought have been greater or better than hers; no moulding of political or social institutions has been wiser than hers; nowhere on the continent has literature touched a higher level than on her shores or her western hills; nowhere has high thinking been better combined with living made subservient to the intellectual life.

We see these things—we admire, but we do not wonder, for we know the stock which first settled Massachusetts Bay. Putting religion in a place, some think, too high for mortal powers, they came from school and college in the old world, and brought to the new a profound sympathy with learning and scholarship and literature. These men, their spirit, their foundations of universities, their keen intellectual life, have made this commonwealth one whose guests we are proud to be, sure of welcome, sure of *appreciative* welcome, which receives us for what we are.

We are an association for the advancement of science. Some of us advance science chiefly by expressing our interest in it. Some of us, burdened with much teaching, find in that the limit of our opportunities. But some of us try to enlarge the borders of science, and to add to the world's stock of knowledge. These last ought to be considered as the more important part of our society, and as the proper index to its character.

Now, the advancement of science ministers chiefly to purely intellectual wants. Science is not the apple tree nor the vine, bearing fruit for the body. It is the elm or the lily; carefully nurtured, highly prized, because it ministers to higher necessities, to intellectual or esthetic wants. Of course, many purely scientific discoveries have become the basis of inventions which have conferred enormous material benefits; some value science chiefly or wholly because of the promise of further material advantages; they esteem the elm because sometime it may perhaps support the vine. But we who love science and give to it much labor and weariness, value it chiefly because of the intellectual benefits which it confers on our race. And in this ancient commonwealth, we feel that you value every source of intellectual uplifting and intellectual inspiration. We think, and I am sure so do you, that this world is a better place for men

to live, now that we know its size, even if we can make no material profit from the knowledge. We think, with you, that this continent is a better home for intellectual beings, now that the history of its formation has been made out by the combined labors of so many eminent geologists, and has been told with such a wealth of learning and such skill of exposition by one of our past Presidents, who has been taken from us since we last met, not till he had completed his work. The knowledge of the distance of the sun makes no one richer, or warmer, but it makes some of us, happier, by satisfying the ennobled and ennobling curiosity which seeks to learn all which is now unknown.

So we, who are fascinated with science, justify our devotion to it by the intellectual benefits which our devotion confers on our fellow men. So we ask you to receive us, not as engineers, promising new structures or flying ships; not as inventors, creating new sources of income and new comforts; not as ethical teachers, for science cannot change human nature or the social order; not even as those who would make two ears of corn grow where one grew before; but as those who would make two lilies grow for one in the garden of the nation's intellectual life.

We wish we could make some return for your generous welcome, in kind, in any way; but we cannot. We can only thank you; we thank you again, and again.

At the close of President Morley's address, the GENERAL SECRETARY made the following announcements:—

1. Owing to the unavoidable absence of the Vice Presidents of Sections A and F, the COUNCIL presents the following nominations:

For Vice President of Section A, Prof. EDGAR FRISBY of U. S. Naval Academy, Washington, D. C.

For Vice President of Section F, LELAND O. HOWARD, Chief of Division of Entomology, Department of Agriculture, Washington.

On motion the GENERAL SECRETARY was unanimously directed to cast the ballot of the Association for the above nominees, which was done, and they were declared elected.

2. The COUNCIL recommends that the sessions of the Sections of the Association be on Friday, Monday, Tuesday and Wednesday, from 10 A. M. to 12 M., and from 2 to 5 P. M., with the exception of Monday afternoon, when the sections will adjourn at 4 o'clock. This recommendation was on motion adopted by the Association.

3. That Sections F and G had agreed to postpone the proposed joint session of Friday morning to Monday morning, and that section F would meet in Evangelist Hall on Friday morning to hear such papers as required lantern illustration.

4. All reports of SPECIAL COMMITTEES of the Association must be presented not later than Monday.

5. The COUNCIL directs the reading of the following communications, relative to the resolutions of the Association at the last meeting, on the subject of protection of public forests:

United States Department of Agriculture,
Office of the Secretary,
Washington, D. C., Jan. 22, 1895.

F. W. PUTNAM, PERMANENT SECRETARY,
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,
PEABODY MUSEUM, HARVARD UNIVERSITY,
CAMBRIDGE, MASSACHUSETTS.

DEAR SIR:—

I have the honor to acknowledge, in the absence of the Secretary, the receipt of a copy of resolutions passed by the American Association for the Advancement of Science, recommending legislation for the protection of the public forests. I need not add that this Department is fully in sympathy with the objects and measures proposed in the set of resolutions. The fact that the Secretary is the President of the American Forestry Association may be sufficient assurance that his sympathy lies in the same direction.

Respectfully,
CHAS. W. DABNEY, JR.,
Acting Secretary.

War Department,
Washington, D. C., January 30, 1895.

SIR:—

I have the honor to acknowledge the receipt of a copy of the Resolution of the American Association for the Advancement of Science in the matter of the protection and rational use of our forest reserves, and suggesting the establishment of a chair of forestry at West Point, and beg to quote for the information of the Society the remarks of the Major General Commanding the Army upon the subject, dated the 23d instant, in whose views I concur.

"The first and second of the Resolutions of the American Association for the Advancement of Science are surely worthy of the most cordial approval. In respect to the third Resolution, it must doubtless be admitted that the military forces of the United States must be employed for the protection of property of so great value as the public reservations, so long as no civil organization is provided for the purpose. But in the interest of the military service, it is hoped that such employment will be only temporary. However this may be, only a small fraction of the Army can ever be employed in that way. Hence, there can be no necessity for general education of the officers of the Army in the art of forestry. The time allotted to the course of instruction at the Military Academy is now thoroughly occupied by subjects of education, all of which are indispensable to the efficiency of all officers. It cannot therefore be advised that a Chair of Forestry be established at West Point."

Very respectfully,
JOSEPH B. DOE,
Assistant Secretary of War.

F. W. PUTNAM, ESQ.,
PERMANENT SECRETARY,
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,
SALEM, MASS.

The PERMANENT SECRETARY then called attention to the announcements of the meetings as given on the daily program, and stated that in the absence of the retiring President, the presidential address would be read by Prof. JAS. LEWIS HOWE, the General Secretary.

The Secretary of the Local Committee Mr. WM. A. WEBSTER, called

attention to various points given in the daily program, to the fact that rooms for "Section Q" were provided across the street from the headquarters, and to the lunch daily at Armory Hall.

Prof. WM. ORR, JR., Chairman of Committee on Excursions, made several announcements, after which the Session adjourned.

EVENING SESSION OF THURSDAY, AUG. 29. The Association convened in the Court Square Theatre, President MORLEY in the chair. In a few words the President deplored the absence of Dr. D. G. BRINTON, the retiring President, and introduced Prof. HOWE, the General Secretary, who read President Brinton's address, upon "The Aims of Anthropology." [The address is printed in full elsewhere in this volume.]

After the address an adjournment was made to the City Hall where a reception was tendered the Association by the LADIES' RECEPTION COMMITTEE.

GENERAL SESSION OF FRIDAY, AUG. 30. The Association was called to order in the usual place, the PRESIDENT in the chair.

The GENERAL SECRETARY announced that the place of meeting of Section D had been changed to Room 4, High School Building.

An abstract of the Treasurer's report was read by R. S. WOODWARD, Treasurer.

An abstract of the Finance report of the Permanent Secretary was read by F. W. PUTNAM, Permanent Secretary. [These reports appear in full elsewhere in this volume.]

The following resolution was then passed and ordered to be transmitted to President BRINTON:—

Resolved: That The American Association for the Advancement of Science, in session assembled at Springfield, conveys to its retiring President, Dr. D. G. Brinton, the expression of its sincere sympathy with him in the serious illness of Mrs. Brinton, and its regret at his inability for that reason to participate in the annual gathering.

The PERMANENT SECRETARY then read the following list of names of deceased members, notices of whose death had been received since the last meeting:—

Armsby, James H., Albany, N. Y. (6). Born in Sutton, Mass., Dec. 31, 1810. Died in Albany, N. Y., Dec. 3, 1875.

Beman, Nathan Sidney Smith, Troy, N. Y. (6). Born in Canaan, N. Y., Nov. 26, 1785. Died in Carbondale, Ill., Aug. 6, 1871.

Brinsmade, Thomas C., Troy, N. Y. (6). Born in New Hartford, Ct., June 16, 1802. Died in Troy, N. Y., June 22, 1868.

Broomall, John M., Media, Pa. (23). Died June, 1894.

Buel, David, Jr., Troy, N. Y. (6). Born in Litchfield, Ct., Oct. 22, 1784. Died in N. Y., 1860.

Carpmael, Charles, Toronto, Can. (31). Died Oct. 20, 1894.

Colman, Henry, Lynn, Mass. (25). Died Nov., 1893.

Cresson, Hilborne T., Philadelphia, Pa. (39). Died in New York, N. Y., Sept. 6, 1894.

Dana, James Dwight, New Haven, Ct. (1). Born in Utica, N. Y., Feb. 12, 1813. Died in New Haven, Ct., April 14, 1895.

Dorsey, J. Owen, Takoma Park, D. C. (31). Died Feb., 1895.

Eaton, D. G., Brooklyn, N. Y. (19). Born in Portland, Me., March 6, 1822. Died in Brooklyn, N. Y., March 18, 1895.

Greene, Benjamin Franklin, Troy, N. Y. (2). Born in Lebanon, N. H., Oct. 25, 1817.

Greene, Thomas A., Milwaukee, Wis. (31). Died Sept., 1894.

Hall, Stanton I., Port Chester, N. Y. (36). Born in Pittsfield, Mass., 1842.

Hayes, Richard, St. Louis, Mo. (27).

Holmes, Oliver Wendell, Boston, Mass. (29). Born in Cambridge. Mass., Aug. 29, 1809. Died in Boston, Mass., Oct. 7, 1894.

Horton, Samuel Dana, Pomeroy, Ohio (37). Died Feb., 1895.

Jenks, John Whipple Potter, Middleborough, Mass. (2). Born in West Boylston, Mass., May 1, 1819. Died in Providence, R. I., Sept. 26, 1894.

Judd, Orange, New Haven, Ct. (4). Born near Niagara Falls, N. Y., July 26, 1822. Died in Evanston, Ill., Dec. 27, 1892.

Lamborn, Robert H., New York, N. Y. (28). Born in 1836. Died in New York, N. Y., Jan. 14, 1895.

Liebig, G. A., Baltimore, Md. (30). Died Dec., 1893.

McNaughton, James, Albany, N. Y. (4). Born in Kenmore, Scotland, Dec. 10, 1796. Died in Paris, France, June 18, 1874.

McNaughton, Peter, Albany, N. Y. (10). Born in Kenmore, Scotland, Dec. 6, 1800. Died in Albany, N. Y., Dec. 18, 1875.

Mallery, Garrick, Washington, D. C. (26). Born in Wilkesbarre, Pa., 1831. Died in Washington, D. C, Oct. 24, 1894.

March, Alden, Albany, N. Y. (4). Born in Sutton, Mass., Sept. 20, 1795. Died in Albany, N. Y., June 17, 1869.

Monselise, Giulio, Milan, Italy (40). Died Dec. 18, 1894.

Nason, Henry Bradford, Troy, N. Y. (13). Born in Foxboro, Mass., June 22, 1831. Died Jan., 1895.

Oliver, James Edward, Ithaca, N. Y. (7). Born in Portland, Me., July 27, 1829. Died in Ithaca, N. Y., March 27, 1895.

Peter, Robert, Lexington, Ky. (29). Born in Cornwall, Eng., Jan. 21, 1805. Died near Lexington, Ky., April 26, 1894.

Phillips, Henry, Jr., Philadelphia, Pa. (32). Born in Philadelphia, Pa, Sept. 6, 1833. Died in Philadelphia, Pa., June 6, 1895.

Pilling, James C., Washington, D. C. (28). Died 1895.

Rauch, John H., Springfield, Ill. (11). Died in Lebanon, Pa., 1894.

Redfield, John H., Philadelphia, Pa. (1). Born in Middletown, Ct. Died in Philadelphia, Pa., Feb. 27, 1895.

Reynolds, Sheldon, Wilkesbarre, Pa. (33). Born in Kingston, Pa., Feb. 22, 1845. Died at Saranac Lake, N. Y., Feb. 8, 1895.

Ryder, John Adams, Philadelphia, Pa. (33).

Scherzer, William, Chicago, Ill. (39). Died July 20, 1893.
Skilton, Avery Judd, Troy, N. Y. (6). Born in Watertown, Ct., Feb. 1, 1802. Died in Troy, N. Y., March 20, 1858.
Smucker, Isaac, Newark, Ohio (29).
Swinburne, John, Albany, N. Y. (6). Born in Denmark, N. Y., May 30, 1820. Died in Albany, N. Y., March 28, 1889.
Thorn, James, Troy, N. Y. (10). Born in Colchester, Eng., June 20, 1802.
Van der Weyde, Peter H., New York, N. Y. (17). Born in Nymegen, Holland, 1813. Died in Brooklyn, N. Y., March 17, 1895.
Whelen, Edward S., Philadelphia, Pa. (33). Died Feb. 14, 1894.
Wood, Robert M., Jamaica Plain, Mass. (29). Died in Jamaica Plain, Mass., Jan. 24, 1892.

Resolutions offered by Dr. W. H. HALE, of Brooklyn, favoring the use of Indian terms as names of localities, and relative to the next two meetings of the Association, were referred to the Council.

The session then adjourned.

EVENING SESSION OF FRIDAY, AUG. 30. Held in the City Hall, at 8 o'clock, President MORLEY in the chair.

The President introduced Prof. W. M. DAVIS, of Harvard University, who delivered a lecture, illustrated by stereopticon views, upon "The Geographical Structure of the Connecticut Valley."

SATURDAY, AUG. 31. This day was given up to excursions to Amherst College and Amherst Agricultural College; to Smith College, Northampton, to Holyoke College, South Hadley; and to an archæological excursion to Hatfield.

GENERAL SESSION OF MONDAY, SEPT. 2. The meeting was called to order in the usual place, at 10 A. M., by President MORLEY, and after announcement of meetings by the GENERAL SECRETARY and PERMANENT SECRETARY, the session was adjourned.

SESSION OF TUESDAY, SEPT. 3. The meeting was called to order by President MORLEY at the usual place at 10 A. M.

The GENERAL SECRETARY made the following announcements:—

1. The COUNCIL recommends the election of Prof. RUDOLPH LEUCKART of Leipzig and Dr. BENJ. APTHORP GOULD, of Cambridge, as HONORARY FELLOWS of the Association.

On motion the GENERAL SECRETARY was unanimously instructed to cast the ballot of the Association for the above, and they were declared by the PRESIDENT duly elected Honorary Fellows.

2. The COUNCIL elected at its meeting of current date as Fellows of the Association the following members:—

Adriance, John S., 231 Broadway, New York, N. Y. (39). **C**
Austen, Peter T., Polytechnic Inst., Brooklyn, N. Y. (44). **C**
Baker, Prof. Arthur Latham, Rochester, N. Y. (41). **A B**

Carter, James Madison G., M.D., Waukegan, Ill. (39). **F G**
Carus, Paul, Ph.D., La Salle, Ill. (40). **H**
Catlin, Charles A., 133 Hope St., Providence, R. I. (33). **C**
Clarke, Robert, Cincinnati, Ohio (30). **H**
Curtman, Dr. Charles O., 3718 North 9th St., St. Louis, Mo. (39). **C**
Dawson, Geo. M., D.S.C., F.G.S., Geol. Surv., Ottawa, Ontario, Can. (38). **E**
Dennis, Louis Munroe, Cornell Univ., Ithaca, N. Y. (43). **C**
Dexter, Julius, Cincinnati, Ohio (30).
Frost, Howard V., Ph. D., Arlington, Mass. (38). **C**
Haliburton, R. G., Q.C., 99 State St., Boston, Mass. (43). **H**
Hallock, Albert P., Ph.D., 440 First Ave., New York, N. Y. (31). **C**
Halstead, D. B., 335 Washington Ave., Brooklyn, N. Y. (43).
Harper, Prof. Charles A., Univ. of Cincinnati, Cincinnati, Ohio (40). **C**
Harrington, Mark W., Pres. Washington State Univ., Seattle, Washington (40). **B**
Harris, Abram W., Sc.D., Pres. Maine State College, Orono, Me. (40). **C**
Herty, Chas. Holmes, Ph.D., Univ. of Georgia, Athens, Ga. (42).
Hill, David J., Pres. Univ. of Rochester, Rochester, N. Y. (41). **H I**
Hillyer, Homer W., Ph.D., Univ. of Wis., Madison, Wis. (42). **C**
Hooper, Prof Franklin W., Curator Brooklyn Inst., Brooklyn, N. Y. (43). **F H**
Hovey, Edmund O., Amer. Mus. Natural History, New York, N. Y. (36). **C E**
Hubbard, Henry Guernsey, U. S. Supt. Agriculture, Washington, D. C., Detroit, Mich. (41). **F**
Jackson, Prof. Charles L., Harvard Univ., Cambridge, Mass. (44). **C**
Livermore, Wm. R., Maj. of Engineers, U. S. A., P. O. Building, Boston, Mass. (38). **B H**
Long, Prof. John H., 40 Dearborn St., Chicago, Ill. (41). **C**
McClintock. Emory, Morristown, N. J. (43). **A**
McCurdy, Chas. W., Sc.D., Prof. of Chemistry, Univ. of Idaho, Moscow, Idaho (35). **C E**
Marlatt, Charles L., 1st Asst. Entomologist, Dept. of Agric., Washington, D. C. (40). **F**
Mell, Prof. P. H., Polytechnic Inst., Auburn, Ala. (39). **E F**
Mills, James. President Agricultural College, Guelph, Ont. (31). **I C**
Mohr, Dr. Charles, Mobile, Ala. (40). **G**
Orr, William, Jr., Firglade Ave, Springfield, Mass. (39). **F B**
Phillips, Dr. Wm. A., Evanston, Ill. (41). **H**
Pierce, Perry Benj , U. S. Patent Office, Washington, D. C. (40). **H**
Saunders, Prof. Charles E., 233 Robert St., Toronto, Can. (41). **C**
Schwarz, E. A., U. S. Dep't of Agric., Washington, D. C. (29). **F**
Scull, Miss Sarah A., 1100 M St., Washington, D. C. (40). **H D C**
Sabine, Wallace Clement, Assistant in Physics, Harvard University, Cambridge, Mass. (39). **B**
Schurmann, Jacob G., President Cornell Univ., Ithaca, N. Y. (41). **H**

Simon, Dr. Wm., 1348 Block St., Baltimore, Md. (29). C
Skilton, James A., Brooklyn, N. Y. (43). I
Spenzer, John G., M.D., 368 Central Ave., Cleveland, Ohio (37). C
Speyers, Clarence L., Rutgers College, New Brunswick, N. J. (36). C
Steinmetz, Chas. Proteus, Gen. Electric Co., Schenectady, N. Y. (40). B
Stevenson, Mrs. Cornelius, Philadelphia, Pa. (33). H
Stieglitz, Dr. Julius, Univ. of Chicago, Chicago, Ill. (39). C
Tesla, Nikola, LL.D., 55 W. 27th St., New York, N. Y. (43). B
Thaw, Mrs. Mary Copley, Pittsburgh, Pa. (41). H
Tooker, William Wallace, Sag Harbor, N. Y. (43).
Updegraff, Milton, Observatory, Columbia, Mo. (40). A
Veeder, Major Albert, M.D., Lyons, Wayne Co., N. Y. (36).
Voorhees, Louis A., Agric. Exp. Station, New Brunswick, N. J. (43). C
Weld, Prof. Laenas G., State Univ. of Iowa, Iowa City, Iowa (41). A
West, Dr. Charles E., Brooklyn, N. Y. (1).
Wilson, Robert N., Macleod, Alberta, Can. (42). H
Woodrow, James, Pres. South Carolina Coll., Columbia, S. C. (44). E

3. The Committee on the Library of the Association has made the following report to the Council:—

SPRINGFIELD, MASS., Sept. 2, 1895.

The Committee appointed by the Council on Jan. 26, 1895, to consider "the desirability of placing the Library of the Association in some institution of learning not provided with a large library, where it would be cared for and made useful to workers in Science and also to members of the Association," begs leave to report as follows:

The Library of the Association is located at present in the office of the Association at Salem, Mass. It consists of 638 bound volumes, 1628 unbound volumes and 6,443 pamphlets. The present rate of increase is about 250 volumes and over 300 pamphlets yearly. There are 248 regular foreign and American exchanges.

The location of the library in the immediate neighborhood of the great collections of Boston and Harvard, as well as of similar scientific libraries in Salem, renders it at present of practically no value to the cause of science.

While not large as yet, it still contains much of value, and a number of monographs and serial publications not apt to be found in American libraries.

It would seem, especially in view of the contributional provisions, for the usefulness of the library that steps should be taken to render it more valuable to the cause of science.

Your committee, after careful consideration of the subject, is convinced this could best be attained by locating the library in some institution of learning in warm sympathy with the work of the Association, where ample library facilities are as yet lacking.

Since the organization of the Committee in the month of February, invitations have been received from two Universities who would willingly assume the care and responsibility of the library; these are Washington and Lee University at Lexington, Va., and the University of Cincinnati, at Cincinnati, O.

Your committee regards both of these institutions as standing on very nearly the same footing with regard to lack of library facilities, and as coming unquestionably within the category above defined.

As the two propositions differ radically in their nature, your committee prefers to defer all expression of choice in the matter to the Council.

In view of the above facts your committee would respectfully recommend the following resolutions:—

Resolved, that this Council approve of the location of the Library of the Association, within constitutional requirements, and under proper safeguards, in a satisfactory institution of learning.

Resolved, that Washington and Lee University and the University of Cincinnati, offer satisfactory guarantees for the careful management of the Library, and that after the reading of the Memorials and correspondence connected therewith, from both Universities, a vote be taken as to which proposition is to be preferred and accepted.

Resolved, that the President and Permanent Secretary be authorized to execute the necessary contracts for carrying into effect whichever proposition is accepted.

Respectfully submitted,

T. H. NORTON,
J. LEWIS HOWE,
F. W. PUTNAM.

And the COUNCIL has adopted this report and decided to place the Library in the custody of the University of Cincinnati, subject to the provisions of the agreement.

The PERMANENT SECRETARY then made remarks relative to the Grant to "Science" and the application for grants to the Laboratory tables at Wood's Holl, and Naples, and to Professor Rogers for determination of coëfficients of expansion of metals, and to the International Committee on Bibliography of Zoölogy. He said that owing to three successive meetings which for several untoward circumstances had small attendance, it is desirable for members and friends of the Association to increase the sum available for grants by small contributions, and the Association will gladly welcome such aid.

Dr. C. S. MINOT said he felt that the Permanent Secretary had omitted an important fact, viz.: that he and the President and the Treasurer had felt this matter so important that they had themselves generously subscribed to this object and other members of the Council had also made contributions.

After further remarks by the TREASURER and Prof. COPE, and the suggestion by Prof. BUSHROD W. JAMES, that notice of this matter be brought to all the members, the session adjourned.

EVENING SESSION, TUESDAY, SEPT. 3. Held in the City Hall at 8 P. M., President MORLEY in the chair.

An illustrated public lecture complimentary to the citizens of Springfield, was delivered by Mr. CORNELIUS VAN BRUNT of New York, on "The Wild Flowers of the Connecticut Valley." The lecture was beautifully illustrated by lantern slides colored by Mrs. VAN BRUNT, the slides being made from photographs of the flowers and plants taken by Mr. Van Brunt.

SESSION OF WEDNESDAY, SEPT. 4. The Association was called to order at 10.30 A. M., in the usual place, the PRESIDENT in the chair.

The GENERAL SECRETARY presented the nominations by the NOMINATING COMMITTEE for officers of the Association for 1896.

The GENERAL SECRETARY was unanimously authorized to cast the ballot of the Association for the persons nominated. The Chair declared them duly elected. [The list of officers elected is printed on page xviii of this volume.]

The GENERAL SECRETARY announced that invitations have been received for the Association to hold its next annual meeting in ST PAUL, in Indianapolis, in Colorado Springs and in Buffalo. He read the following invitations and referred to the invitations from Buffalo, printed in the Proceedings of the Brooklyn meeting, pages 454 and 455.

Indianapolis, July 17, 1895.

MR. F. W. PUTNAM, PERMANENT SEC. A. A. A. S.,
HOTEL ENDICOTT, MANHATTAN SQUARE, NEW YORK.

DEAR SIR:

We thank you for your cordial letter of the 14th inst. We regret that the chance of our being permitted to entertain you next year is so slight. Nevertheless, the Commercial Club, an organization with a membership of 1,600 men representative of all that Indianapolis is and has, wishes to extend to the American Association for the Advancement of Science an invitation to hold either its 1896 or 1897 convention here.

As to the accessibility of Indianapolis, we call attention to the fact that 129 scheduled passenger trains daily pass in and out of our Union Station, over 16 lines of railway.

As to the hospitality to be expected, we hope very much that we can refer to your former meeting in Indianapolis.

As to the facilities for accommodating and entertaining guests, we cannot now with a city of 180,000 inhabitants, refer to your former experience here, when the population, with all that that implies, was less than half of what it now is.

I shall be very much indebted to you, Mr. Putnam, if you will be kind enough to take the trouble to advise me of anything that I can do toward enforcing our invitation.

Very truly,
EVANS WOOLLEN,
Secretary.

St. Paul, Minn., August 30, 1895.

PROF. F. W. PUTNAM, PERMANENT SECRETARY, SPRINGFIELD, MASS.

DEAR SIR:

I am instructed on behalf of the Commercial Club of this city, which is acting in co-operation with all our public bodies, to tender to the American Association for the Advancement of Science a hearty and unanimous invitation to select our city as its next place for meeting. We suggest the State Capitol building as a most proper and commodious building for this purpose; and its various rooms and apartments, together with the rooms of the Commercial Club of St. Paul, the Commercial Club of Minneapolis, the new and commodious quarters of the Chamber of Commerce, the Jobbers Union, and other desirable quarters and halls, will be placed entirely at the disposal of your Association and its kindred societies.

Your Council will kindly recall that, at the time of the Nashville meeting, eighteen years ago, the writer had the honor of bringing to Nashville and presenting to your Association a similar invitation from St. Paul, and the same received your attention at that time. The meeting, however, was held elsewhere, much to our regret. Now, after nearly two decades have passed, and our twin cities have grown to a joint population of 350,000, we hope that you may see fit to accept this invitation which comes spontaneously from all our citizens, voiced not only by themselves individually, but through their various public organizations as well, and it is an invitation in which the citizens of Minneapolis and the University of Minnesota will heartily join and support.

We in the western country feel that we need in the greatest degree just that influence which it is the particular province of the American Association for the Advancement of Science to foster. It is entirely within our power to assure the Association the very best of hospitality, every facility which it could desire, and as

many natural attractions, interesting points, scientific features of much value as any other locality which could possibly be chosen. Our beautiful lakes, our cool summer climate, and geographical location, add largely to the advantages which St. Paul offers as a meeting place. And, while all this is true, our citizens feel that the greatest benefit from your visit would be theirs.

In the event of your Council deciding upon some other point for holding the meeting of 1896, we sincerely hope that you will accept this as an invitation to come to St. Paul the following year.

In the latter case it is manifest that St. Paul would be a particularly convenient point for such persons as might wish to attend the meeting, and at the same time perhaps meet personally some of the British Association but who have to come from Canadian northwest. Most of the travel from Winnipeg and Brandon, as well as nearly all of that coming from the British northwest passes through St. Paul, besides which a visit to our section would form a very delightful extension to the journey of the British Association members.

Very respectfully yours,
HERBERT W. SMITH,
Special Committee from St. Paul Commercial Club and St. Paul Academy of Science.

31 August, 1895.

PROF. F. W. PUTNAM, Per. Secretary, A. A. A. S.

MY DEAR SIR:

I am just in receipt of the following telegram from St. Paul:

St. Paul, Minn., Aug. 30, 1895.

HERBERT W. SMITH, ESQ.,
CARE CONVENTION A. A. A. S., SPRINGFIELD, MASS.

"The Commercial Club and Wholesale Jobbers Union of St. Paul cordially invite the American Association for the Advancement of Science to hold their next meeting at the twin cities."

W. J. FOOTNER,
President Commercial Club,
R. A. KIRK,
President Jobbers Union.

Asking the kind consideration of the Council, I am

Very truly yours,
HERBERT W. SMITH,

St. Paul, Minn., Sept. 3.

PROF. F. W. PUTNAM,
PERMANENT SECRETARY, A. A. A. S.

The City of St. Paul and St. Paul Chamber of Commerce cordially invite your Association to hold its next annual meeting in St. Paul.

JOSEPH EHRMANTROUT, JR.
Acting Manager,
E. W. PEET,
Acting President St. Paul Chamber of Commerce.

Colorado College,
Colorado Springs, Colo., July 30, 1895.

F. W. PUTNAM, ESQ.,
MY DEAR SIR:

It gives me great pleasure to unite with many other of our citizens and members of our faculty in extending a cordial invitation to the American Association for the Advancement of Science to hold its next meeting at Colorado Springs.

The Board of Trustees of Colorado College gladly tender you the use of the college buildings together with the Coburn Library and its hall for the use of the Association while holding its meetings.

Trusting that you may see your way to accept this invitation,

Believe me, sincerely yours,

WILLIAM F. SLOCUM,
President.

Chamber of Commerce of Colorado Springs, Colo.
Colorado Springs, Colo., August 6, 1895.

MR. F. W. PUTNAM, PERMANENT SEC'Y,
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,
CAMBRIDGE, MASS.

DEAR SIR:

Colorado Springs extends to the American Association for the Advancement of Science a most cordial invitation to hold its 1896 convention, and as many subsequent ones as it may desire, in our city at the foot of Pike's Peak.

Its situation in the midst of wonders of scenery that have made famous the region about the base of Pike's Peak, its charm of climate, its accessibility from all directions, situated as it is upon six trunk lines of railway, together with its distinctive resort features which make it the charming place of residence of thousands of tourists and health-seekers from all parts of the world,—these constitute it the ideal place for the holding of conventions. It is annually visited by thousands of tourists and health-seekers, who are delighted with our climate, our scenery, our ample accommodations of all classes and the moderate charges therefor, and with the welcoming hospitality they find on every hand.

For the members of your Association, Colorado Springs has some particular attractions. The botanist will revel in the Rocky Mountain flora, and the geologist will find a wealth of interest in the numerous great cañons in our immediate vicinity, Colorado Springs is the seat of Colorado College, and is rapidly becoming the educational center of the far west. President Slocum has written you of the welcome which the College will extend and has doubtless placed at your disposal the several audience rooms in the College and Coburn Library. In addition, we have a Coliseum Hall seating 2500, an opera house seating 850, an auditorium in our High School seating 650, together with a half dozen large churches accommodating from 600 to 1,000 each. It will therefore be seen that ample provisions can be made for the numerous meetings which are simultaneously held by the different branches of your Association.

Our arrangements for accommodating large parties of people in Colorado Springs are very complete and have been tested upon numerous occasions. At the time of the Knights Templar Conclave, three years ago, we roomed as many as one thousand persons daily for fully a week, and on the recent convention of the N. E. A., we roomed fully two hundred daily. In addition to our several hotels, of which there are four, with a total of 700 rooms and with rates ranging from $1.25 to $5.00 per day, we have numerous boarding-houses of all classes and charging all prices, as well as hundreds of lodging rooms scattered throughout the city which can be rented by the day or week. These rooms range in price from 50 cents to $1.00 per day, and from $1.50 to $5.00 per week. Board can be had at the numerous restaurants and boarding-houses.

To afford accommodations to the larger bodies of visitors, our Chamber of Commerce some years ago organized a Bureau of Information. This Bureau is centrally located at No. 3 Pike's Peak Ave., directly opposite the east entrance of the Antler's Hotel. At this Bureau will be found listed the several hotels, boarding-houses and restaurants, together with hundreds of lodging rooms.

Courteous attendants are in readiness to direct visitors to these available quarters, and in addition to give all information concerning our city and the points of interest in the vicinity.

By utilizing this Bureau of Information—which it is scarcely necessary to add is at the service of our visitors without any charge whatever—accommodations of thoroughly delightful and satisfactory character can be had in our beautiful city. The

ability to secure such accommodations at prices to suit the individual purses induces many of our visitors to make a longer stay in the Pike's Peak Region than they would otherwise feel able to make. We should also be very glad to have members of the Association use our Chamber of Commerce as a sort of headquarters while they are in the city, using it as a meeting place and also having their mail if desired directed in our care. Indeed, we trust your Association, should it decide upon Colorado Springs, will feel free to make any use of our rooms or ourselves that would contribute to their pleasure and satisfaction while in the Pike's Peak Region.

It may not be amiss to remind you that Cripple Creek, the new gold wonder and the greatest gold mining camp in the United States, is within a very short distance of Colorado Springs, being but fifteen miles in an air line and but thirty miles by the nearest railroad. From this camp, which is but four years old, fully three-quarters of a million dollars in yellow gold is now flowing each month. Cripple Creek is therefore a most important addition to the numerous points of interest in our immediate vicinity.

I give myself the pleasure of sending you by express a copy of my book on the Pike's Peak Region which perhaps better than anything else will inform yourself and the members of the committee regarding Colorado Springs and the region in which it is situated.

We sincerely trust that Colorado Springs may be chosen for your next convention, and you may rest assured that nothing will be spared to make your stay in our region both delightful and profitable.

Yours very respectfully,

GEO. R. BUCKMAN,

Secretary.

University of Nebraska,
Lincoln, Nebraska, U. S. A., Aug. 16, 1895.

F. W. PUTNAM,
PERMANENT SEC'Y A. A. A. S.,

DEAR SIR:

I wish most heartily to recommend Colorado Springs as a place for the meeting of the Association in 1896. I have carefully looked over the whole situation, and am certain that the Association could not make a better selection of a place of meeting.

The buildings for holding the meetings are as follows:

1. The large hall on Nevada and Kiowa Sts. (called the "Coliseum"), seating 2000 people.

2. The Auditorium in the High School building (Nevada and Platte Sts., two blocks from Coliseum), seating 1000 to 1200 people.

3. The "study room" of the High School building, seating 600 to 700 people.

4. Eight rooms in the High School building, seating from 75 to 100 people each.

5. Several large churches within a couple of blocks of the foregoing, each capable of accommodating several hundred people.

6. The rooms in Colorado College (if necessary) about half a mile away, and readily accessible by car line (electric).

Rooms for offices of various kinds may be obtained in the High School building.

Hotel accommodations are ample for any attendance we might hope to have. In Colorado Springs there are "The Antlers," "Alta Vista," "Alamo," "Elk," "Spaulding," and several others, while in Manitou (30 minutes by electric car), are the "Mansions," "Manitou," "Cliff," "Barker," "Ruxton," "Iron Springs," etc. Altogether these hotels can easily accommodate 2500 to 3000 guests.

I most heartily recommend that the Association arrange to meet next year in Colorado Springs.

Very truly,

CHARLES E. BESSEY.

Colorado Springs, Colo., Aug. 26, 1895.

PROF. F. W. PUTNAM,
PERMANENT SECRETARY,
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

DEAR SIR:

We are not in the least alarmed by the prospect of work and expense in connection with the meeting of your Association in Colorado Springs as indicated by your letter and the copy of the advance circular duly received. I am confident that, with the co-operation of our college people, this work could be done to the entire satisfaction of the Association, and I am likewise confident that the expense could be easily met. The invitation stands; and if there was anything further I could say to emphasize it, I would say it at this time. I think the matter however was fully covered in my previous letter as well as in the letter of President Slocum.

We expect to have the 1896 convention and we shall be disappointed if the decision is not reached in our favor.

I have the honor to remain,

Yours very truly,

GEO. R. BUCKMAN,
Secretary.

Springfield, Mass., September 2, 1895.

TO THE COUNCIL A. A. A. S.

GENTLEMEN:

I wish to repeat an invitation, which was presented last year, by the Buffalo Society of Natural Sciences, that the American Association should hold its next annual meeting in the city of Buffalo, N. Y. It is known that the Association has held its meetings in that city in 1866, 1876, and 1886, and it seems quite proper that they should meet there in 1896. It is to be regretted that this invitation could not have been presented in person by Mr. David F. Day, of our Society.

Respectfully submitted,

FRED. K. MIXER,
for The Buffalo Society of Natural Sciences, Buffalo, N. Y.

The NOMINATING COMMITTEE recommends that the meeting of the Association in 1896 be held at BUFFALO, N. Y., beginning MONDAY, AUGUST 24th. It was moved by Dr. H. C. HOVEY and duly seconded that the recommendation of the Committee be adopted. Prolonged debate, participated in by S. D. Peet, W. H. Hale, D. S. Martin, T. C. Mendenhall, E. Frisby, F. W. Putnam, E. D. Cope, W. Hallock, W. H. Brewer and others, led to a division of the question.

1. It was voted unanimously that the next meeting of the Association be held at Buffalo, N. Y.

2. After an informal vote relating to the beginning of the meeting on Monday or Tuesday it was voted that the next meeting should open on Monday.

3. It was voted that the date of opening should be MONDAY, AUG. 24, 1896.

It was then voted that the recommendation of the NOMINATING COMMITTEE, that the next meeting of the Association should be held at Buffalo, N. Y., opening Monday, Aug. 24, 1896, with the General Session at 10 o'clock, A. M., be adopted.

It was then, on motion of the PERMANENT SECRETARY, voted that the thanks of the Association be given for the cordial invitations to hold the next meeting, received from the several cities, and that while accepting the invitation from Buffalo, as recommended by the NOMINATING COMMITTEE, the Association expresses its earnest desire to meet in St. Paul, Indianapolis, and Colorado Springs in the near future.

The session then adjourned to meet at 8 P. M.

GENERAL SESSION OF WEDNESDAY EVENING. President Morley being obliged to leave town in order to take his steamer for Europe, the meeting was called to order by Vice President BREWER, in the Y. M. C. Association Hall, at 8.30 P. M.

The GENERAL SECRETARY made the following announcements:

1. A report of progress has been made by Prof. EDW. HART of Easton, regarding his work on Glucinum, for which he received a grant from the Association.

2. The COUNCIL has received a full report from the management of the Cold Spring Harbor Marine Biological Laboratory, to which a grant of $100 was made, and the report is herewith presented:

The Brooklyn Institute of Arts and Sciences,
Brooklyn, August 30, 1895.

TO PROF. F. W. PUTNAM,
PERMANENT SECRETARY OF THE AMERICAN ASSOCIATION
FOR THE ADVANCEMENT OF SCIENCE, SPRINGFIELD, MASS.

MY DEAR SIR:

At the meeting of the American Association for the Advancement of Science, held in Brooklyn in August, 1894, the Association appropriated, on the recommendation of the Council, $100.00 to be expended at the Biological Laboratory at Cold Spring Harbor, Long Island, the Biological Station for the summer months of the Brooklyn Institute of Arts and Sciences.

As the Secretary of the Board of Managers of the Laboratory of Cold Spring, I beg leave to report that the $100 has been expended in paying for the use during the present summer of 1895 of two private laboratory rooms at this laboratory—each room being completely equipped for the best biological work at the seashore; and that these rooms have been used by Mr. Gilman A. Drew, of Johns Hopkins University, and Mr. M. A. Carleton, of the U. S. Department of Agriculture.

The appointments to the two private laboratories were made by Prof. Daniel S. Jordan, of Palo Alto, California, Vice President of Section F (Zoölogy), and Vice President J. C. Arthur, of Section G (Botany), of the American Association in accordance with the conditions on which the appropriation was made.

Mr. Drew worked continuously at the Laboratory from June 25th to August 30th, upon the Bryozoa of the locality, which is very rich in both marine and fresh water forms, and the researches which he has made during the summer together with those to be made from the valuable material gathered and properly preserved for study, will enable him to publish a monograph containing valuable contributions to our knowledge of the embryology, development and structure of the Bryozoa.

Mr. M. A. Carleton was continuously at work at the laboratory from July 20th to August 25th, upon the Marine Algæ of Long Island Sound, and was also able to work out the germination of several species of Uredineæ.

Both Mr. Drew and Mr. Carleton will continue their work on the subjects of their investigations from the material collected by them and will make each a full report to be presented at the next meeting of the American Association.

Herewith I present brief statements from Messrs. Drew and Carleton of the work

done by them at the Cold Spring Laboratory, and also a brief statement from Prof. Herbert W. Conn, Ph.D., Director of the Biological Laboratory of the Institute, who commends the work of both Mr. Carleton and Mr. Drew.

Thanking the American Association for the Advancement of Science on behalf of the Board of Managers of the Laboratory and the Trustees of the Brooklyn Institute for the generous appropriation made to our Biological Laboratory to promote original research in Biology, I am

Very truly yours,

FRANKLIN W. HOOPER,

Director of Brooklyn Institute of Arts and Sciences.

STATEMENT FROM PROF. HERBERT W. CONN, PH.D.

The appropriation from the American Association has been used to pay for the rental of two rooms known as the American Association Rooms. These rooms have been occupied the present year by Gilman Drew of Johns Hopkins University, and M. A. Carleton of the Department of Agriculture, Washington. The work which the gentlemen have done is indicated by the brief reports which they have written and which accompany this note. Both gentlemen have proved excellent workers, and in my own opinion the appointments made have been excellent ones. The period during which the laboratory is open is of course too short for the *completion* of any extended work, but both gentlemen have obtained a large amount of material which will be the subject of further work and published papers later. The work of Mr. Drew in particular has great promise, and as is indicated by his report bids fair to add greatly to our knowledge of the Bryozoa. The American Association may be sure that the appropriation made to this laboratory has been fully appreciated by those interested in the laboratory as well as by the gentlemen who have directly benefited by it. In my own opinion the appointments made by the Committee were wise ones and the work done by the gentlemen occupying the rooms has been of a high order.

If the Association sees fit to continue the appropriation another year it will be a great help to this school in its endeavor to advance the cause of Biological Science.

H. W. CONN,

Director of Laboratory.

Cold Spring Harbor, Long Island, N. Y.,
August 25, 1895.

United States Department of Agriculture,
Division of Vegetable Physiology and Pathology, Washington, D. C.

DR. H. W. CONN,
DIRECTOR BIOL. LAB. BROOKLYN INST. ARTS AND SCIENCES.

DEAR SIR:

The following is a brief statement of my work done while occupying the room awarded by the A. A. A. S., from July 20 to Aug. 20, 1895:

(1) A very brief study of the following genera of Algæ:

Marine.—Gracillaria, Rivularia, Ectocarpus, Cladophora, Dasya, Enteromorpha, Vaucheria, Fucus, Ascophyllum, Callithamnion, Rhabdonia, Grinnellia, Spyridia, Myriactis, Bangia, Griffithsia, Lyngbya, Microcoleus, Clathrocystis, Symploca, Polycistis (?), Oscillaria, Isactis, Hildenbrandtia, Mesogloia, Ceramum, Chantransia, Porphyra, Polysiphonia, Lomentaria, Bostrychia, Sphacelaria, Stylophora, Leptothrix (?).

Fresh Water. Zygnema, Volvox, Drapernaldia, Cylindrospermum, Dimorphococcus.

(2) In a few cases several species of the same genus were studied and the spore forms worked out.

(3) Eighty mounted slides for the microscope were prepared, mounted in Wood's Medium.

(4) Thirty-three alcoholic preparations were made in small bottles.

(5) About three dozen mounts on white paper were made.

(6) One special collecting trip was made to Oyster Bay, when, besides other

species, a very interesting *Bangia* not hitherto found here was obtained—*Bangia fusco-purpurea.*

(7) In addition to the above, the new region gave opportunity for a little interesting work in my special line of *Uredineæ*, and the germination of a few species was carried out, including one quite exceptional case not hitherto worked on, so far as I recall at present.

(8) I have besides done the usual amount of miscellaneous work in photography, field work, etc.

In conclusion, I am very grateful for the kind reception and encouragement given me, and beg to express my special thanks to yourself, to Professor Johnson, and to the founders of the institution.

Very truly yours,

August 26, 1895. M. A. CARLETON.

The Biological Laboratory of the Brooklyn Institute of Arts and Sciences.
Cold Spring Harbor, L. I., Aug. 22, 1895.

TO THE COMMITTEE HAVING IN CHARGE THE A. A. A. S. TABLES OF THE BROOKLYN BIOLOGICAL LABORATORY.

SIRS:

As the recipient of one of your tables during the summer of 1895, I take pleasure in reporting the line of work to which I have given my attention up to the present time.

Shortly after the laboratory opened, my attention was turned to the Bryozoa by some remarks made by the Laboratory Director, Dr. Conn, and search has revealed the presence of a large and varied number of both marine and fresh-water species.

Thus far the work has been confined to the study of the living animals and to the preservation of material for sectioning and study.

At least thirteen species of Bryozoa have been collected, studied and preserved, and the embryos of seven of the above species have been obtained in the earlier stages of development.

In the case of one species of fresh-water Bryozoan, the name of which I am at present unable to give, I have been fortunate enough to trace the development complete from the egg to the adult and preserve the necessary material for histological work.

My work is far too incomplete to justify me in offering any kind of scientific paper until a more minute and careful study of the present material can be made.

Allow me to thank you for placing a table at my disposal by means of which I have been enabled to prosecute the work mentioned.

At least in the line in which I have worked I have found the locality most favorable, the accommodations ample, and all have been cordial and obliging.

Respectfully yours,

GILMAN A. DREW.

3. The COUNCIL has received the following report from Professor Whitman, Director of the Wood's Holl Laboratory in relation to the grant made for a table for 1895:

Marine Biological Laboratory,
Wood's Holl, Mass., Aug. 27, 1895.

DEAR PROFESSOR PUTNAM:

I have asked Professor Atkinson of Cornell to recommend Maynard M. Metcalf to membership in the A. A. A. S. Metcalf's appointment, as I understand it, stands for the whole season. I believe he has already reported to you on his work.

We have had 196 in attendance this summer, representing 86 different institutions. I shall try to get a new building added for next year, and this will add to our debt. It would be a most welcome assistance if the A. A. A. S. could for next summer support *two rooms*, one for zoölogy and one for botany. Professor Atkinson suggested

this and I hope you will help him carry it through. Certainly the money could hardly count more for science than in this way. The Naples rooms, as you know, are $500 each. Hoping you can give us this encouragement for at least one summer, and trusting that you will have a good meeting,

I am yours, very truly,

C. O. WHITMAN.

4. The COUNCIL has also received the following report from Professors Rogers and Morley relating to the appropriation of $100 for experiments by them.

TO THE COUNCIL OF THE A. A. A. S.

The undersigned beg leave to report that after preliminary experiments, extending over a period of five years and with an expenditure of $2,000, an interferential apparatus has been constructed with which it has been found possible to obtain the coëfficient of expansion between the limits of the freezing and the boiling point and in a vacuum, expressed in terms of the wave lengths of sodium light.

A few minor difficulties still remain to be overcome, but since we have actually obtained the coëfficient of expansion of Jessop's steel between the limits of 0° and 61° it may be said that the feasibility of this new method of observation has been completely established.

The appropriation granted was expended in making the brass boxes containing the bars to be investigated impervious to the air, by covering every part of the outside surface with soft solder. The boxes previously used, although made of rolled brass, could not be made air tight.

WM. A. ROGERS.
EDWARD W. MORLEY.

5. It was voted on recommendation of the COUNCIL that a Committee of eleven consisting of the PRESIDENT, PERMANENT SECRETARY and one member from each section be appointed by the President to enunciate the policy of this Association; that this Committee is empowered to confer with all fellows of the Association and with affiliated scientific societies if deemed advisable, to secure their full and hearty coöperation in the efforts of this Association for the Advancement of Science; that this Committee be directed to report at the next meeting of the Association what changes, if any, in the policy of the Association are deemed expedient to promote its general welfare. The President appointed as the additional members of this Committee, Messrs. WOODWARD, MENDENHALL, HOWE, MERRIMAN, FAIRCHILD, MINOT, BARNES, BOAS and BREWER.

6. It was voted on recommendation of the COUNCIL that a Committee on *Standards of Measurements* be appointed, consisting of T. C. MENDENHALL, Chairman, R. S. WOODWARD, W. A. ROGERS, H. A. ROWLAND, E. L. NICHOLS and H. S. CARHART, and that this Committee have power to add to its number during the year.

7. It was voted that the PRESIDENT appoint a Committee on *Standard Colors and Standard Nomenclature of Colors*, as recommended by Section B. The following Committee was appointed: O. N. ROOD, W. LECONTE STEVENS and W. HALLOCK.

8. The COUNCIL has appointed the PRESIDENT and PERMANENT SECRETARY as a Committee to arrange the bond of the TREASURER and that the amount of said bond be fixed at $12,000.

9. The COUNCIL recommends the adoption of the following resolution offered by Dr. W. H. HALE, that the American Association for the Advancement of Science favors the use of native Indian names for geographical locations as far as is practicable. The resolution was adopted.

10. The COUNCIL recommends the following action in relation to the amendments to the Constitution proposed at the Brooklyn meeting:—That the proposed amendment to ARTICLE 3 in relation to incorporated societies and institutions being admitted to membership in the Association be adopted. On vote this amendment was adopted.

That the proposed amendment to ARTICLE 22 creating a section of geography be not adopted. On vote the recommendation of the COUNCIL was accepted.

That the proposed amendment to ARTICLE 22 changing the name of Section I, be amended and the Section be designated as Section I, Sociology.

After considerable discussion, a vote was taken and the amendment proposed by the COUNCIL was not agreed to.

It was then voted to accept the amendment as proposed at the Brooklyn meeting, by which the section shall be designated, Section I, Social and Economic Science.

That the proposed amendment to ARTICLE 32, in relation to the composition of the Local Committee be not adopted. On vote the recommendation of the Council was agreed to.

That the proposed amendment to ARTICLE 15, in relation to the Treasurer furnishing bonds be adopted. On vote the recommendation of the Council was agreed to.

11. Reports of SPECIAL COMMITTEES were called for and the following disposal of the committees made:

Committee 1. Continued, but to consist of EMORY MCCLINTOCK of Morristown, N. J. and B. A. GOULD of Cambridge.
" 2. Report received and committee continued.
" 3. Report received and committee discharged.
" 4. Committee reported last year and at its own request was discharged.
" 5. No report received and committee discharged.
" 6. Report received and committee discharged.
" 7. No report received and committee discharged.
" 8. No report received and committee discharged.
" 9. Report received and committee continued to consist of *Vice Presidents* of Sections *F* and *G*, *ex officio* and C. O. Whitman of Chicago.
" 10. No report received and committee discharged.
" 11. No report received and committee discharged.
" 12. Committee discharged at its own request.

12. The GENERAL SECRETARY announced that the following grants from the Research Fund had been made by the COUNCIL:

To Prof. W. A. ROGERS to continue his work on coëfficients of expansion of the metals, $100.

To the MARINE BIOLOGICAL LABORATORY at WOOD'S HOLL for an Association table, $100.

Towards the maintenance of the INTERNATIONAL BIBLIOGRAPHICAL BUREAU, $250.

A grant of $5 to SECTION G to print and distribute a second edition of the Rules of Citation.

The COUNCIL had also made a grant of $750 from its current funds to the publisher of "SCIENCE" in good faith for the action taken at the Brooklyn meeting. [The Council authorized the Treasurer to use the General Fund for this purpose, the amount so used to be refunded from Current funds and special subscriptions as available; also to loan from the income of the Research Fund for this purpose if necessary; the amount so used to be refunded in the same manner as the General Fund.]

13. The COUNCIL recommends that two resolutions offered by T. H. Norton relative to the Library of the Association be passed. Adopted as follows:—

Resolved, That the PRESIDENT be authorized to appoint a committee of five Fellows of the Association to supervise during the coming year the library of the Association. The PRESIDENT appointed ALFRED SPRINGER, Chairman, A. W. BUTLER, W. L. DUDLEY, T. H. NORTON, THOS. FRENCH, Jr.

Resolved, That the COUNCIL express to Prof. J. U. LLOYD and Mr. C. G. LLOYD of Cincinnati its thanks for their generous offer with regard to the affiliation of their libraries with the library of the Association, and authorize the committee on library in conjunction with the PRESIDENT and PERMANENT SECRETARY to make satisfactory arrangements with the Messrs. Lloyd in this matter.

14. The COUNCIL recommends the adoption of the following:

Resolved, That a vote of thanks be tendered to Miss C. A. WATSON, the Assistant Secretary, in recognition of her twenty-one years of faithful service to the Association.

The resolution was unanimously adopted.

The PERMANENT SECRETARY presented the following statistics of the meeting:

There have been 368 members and associates in attendance from the following places: Springfield, 15, and other parts of Massachusetts, 56; New York, 90; D. C., 39; Pennsylvania, 29; Ohio, 18; Connecticut, 14; Indiana, 12; Michigan, 11; New Jersey, 8; Wisconsin, 8; Maryland, 6; Virginia, 6; Iowa, 7; Canada, 5; New Hampshire, 5; California, 4; Illinois, 4; Missouri, 4; Rhode Island, 4; S. Carolina, 4; Vermont, 3; N. Carolina, 3; Georgia, 2; Louisiana, 2; Alabama, 2; Maine, 1; Washington, 1; Kentucky, 1; Minnesota, 1; N. Dakota, 1; Florida, 1; Texas, 1.

185 members have been elected; and 58 members have been made Fellows. Notices of the loss of 42 members and fellows by death have been received since the last meeting.

The Retiring President's address and the addresses of 7 Vice Presidents have been given.

Three public lectures have been delivered, all with lantern illustrations.

207 papers have been read in the Sections as follows: A 16; B 34; C 42; D 6; E 19; F 16; G 28; H 33; I 13.

The PERMANENT SECRETARY offered the following resolution:

Whereas, the members of the American Association for the Advancement of Science have been the recipients of numerous courtesies on the part of the city authorities, the public institutions, several organizations and the citizens of Springfield as represented by the Local Committee; therefore be it

Resolved, That the sincere thanks of the Association be and hereby are tendered to

THE LOCAL COMMITTEE for its successful efforts in providing accommodations for offices, for halls for holding the general meetings and for rooms for holding the meetings of the nine sections of the Association, and for its hospitality in extending to the Association several receptions and numerous excursions during the past week.

To the BOARD of TRADE for the use of its office for the business headquarters of the Association, and to the Clerk of the Board, Mr. WILLIAM A. WEBSTER, whose untiring labors and constant courtesy as Local Secretary have been so highly appreciated by the members of the Association.

To the Y. M. C. A. for the use of its beautiful and convenient building for our offices and assembly rooms.

To THE CITY GOVERNMENT for the use of the City Hall for the purposes of the evening lectures given by the Association.

To the SCHOOL COMMITTEE for the use of the High School building which supplied meeting rooms for several sections.

To the PASTORS and TRUSTEES of the STATE STREET BAPTIST CHURCH, the CHURCH OF THE UNITY and CHRIST CHURCH, for the use of their chapels for Sections of the Association. To the TRUSTEES of EVANGELIST HALL for the use of the hall during the time of the meeting.

To Mr. JAMES A. RUMRILL, President, and the CITY LIBRARY ASSOCIATION, for the use of the halls in the Art Building, and for the reception on Wednesday evening, at which time the members of the Association had the opportunity of examining the interesting collections of art and natural history there displayed.

To the LADIES' RECEPTION COMMITTEE for the special courtesies extended to the ladies of the Association and for the several evening receptions given to the sections.

To the UNITED ELECTRIC COMPANY for making the requisite arrangements and furnishing electricity for the lanterns used in the City Hall and in Evangelist Hall during the time of the meeting.

To J. B. COLT & Co., of New York, for their kindness in furnishing lanterns and operator on all occasions requiring lantern illustrations.

To the PRESIDENTS and FACULTIES of AMHERST COLLEGE, MOUNT HOLYOKE COLLEGE, SMITH COLLEGE, MASSACHUSETTS AGRICULTURAL COLLEGE, WILLISTON SEMINARY, and to the citizens of North Hampton, for

their courteous reception and entertainment of the members of the Association during the several excursions to those places.

To COLONEL MORDECAI, Commandant U. S. Armory, for his courteous reception of the members at the U. S. Armory Grounds.

To the SEVERAL MANUFACTURING COMPANIES who opened their works for the inspection of many interested members of the Association.

To the SPRINGFIELD STREET RAILWAY COMPANY for its courtesy in providing cars free of expense for the use of members on the several excursions.

To the WESTERN UNION and POSTAL TELEGRAPH COMPANIES for franking privileges furnished to the Local and Permanent Secretaries, and to the POSTMASTER of Springfield for establishing a branch office at the headquarters of the Association.

To the PROPRIETORS, EDITORS and REPORTERS of the Springfield Republican and Springfield Union for giving to the world carefully prepared reports of the proceedings of the meeting.

The GENERAL SECRETARY read the following resolutions adopted at the meeting of the ladies of the Association:

In view of the exceeding cordiality and thoughtfulness which have marked the provision everywhere made for the comfort and happiness of the ladies in attendance on the present meeting of the A. A. A. S., and realizing that it could only be accomplished by an unusual combination of tact, judgment, and friendly feeling, accompanied by a spirit of generous and discriminating hospitality, that, while leaving them the utmost freedom to make the most of their visit here for their own benefit, has yet met them at every point where attention could be useful with the very service required.

Resolved, That we feel it a privilege and pleasure to express more directly than through the ordinary official proceedings our profound appreciation of the hearty good will and friendly interest that have met and followed us throughout our stay; so that we have not felt ourselves strangers and sojourners, but welcome guests, in this beautiful city of homes.

We therefore direct our Secretary to forward a copy of these proceedings to MRS. LUKE CORCORAN, Chairman of the Ladies' Reception Committee, with the request that she will communicate it so far as may be possible o all those ladies who, individually or in organized capacity, have contributed so successfully to our entertainment.

Resolved, further, that the General Secretary of the A. A. A. S., be requested to read these resolutions at the final session of the Association and to enter them upon its records.

(Signed)

MARY J. EASTMAN,
HELEN W. DOOLITTLE,
ELIZABETH G. BRITTON.

The resolutions were seconded by Messrs. B. W. JAMES, F. H. CUSHING, B. E. FERNOW, H. C. HOVEY, G. W. HOLLEY, J. L. HOWE, H. FAR-

QUHAR, ALICE C. FLETCHER, W. LE C. STEVENS, R. S. WOODWARD, E. D. COPE, and F. W. PUTNAM, and were unanimously adopted.

Ex-Lieutenant Governor HAILE responded to the resolutions in behalf of the Local Committee.

Remarks were made in appreciation of the courtesies of the Kamp Komfort Klub to many members of the Association, especially to those of Section C.

The Association was then declared adjourned to meet at 10 A. M., Monday, Aug. 24, 1896, in Buffalo, N. Y.

JAMES LEWIS HOWE,
General Secretary.

REPORT OF THE PERMANENT SECRETARY.

THE impossibility of making satisfactory arrangements with the transcontinental railways made it necessary to abandon the plan of holding the meeting of 1895 in San Francisco. As soon as this fact was determined, a Council meeting was called on January 26, 1895, when it was decided to accept the invitation of Springfield, Mass., and to postpone the San Francisco meeting to some future date. The forty-fourth meeting was therefore held in Springfield, beginning with the General Session on Thursday, August 29.

As in my last report, I must again refer to the necessity of deciding at one meeting the place of holding the next, as being of vital importance to the interests of the Association. This uncertainty was undoubtedly the cause of the absence of a large number of members from the Springfield meeting.

It was apparent at the Springfield meeting that some coöperative action is essential between the affiliated societies and the Association, by which the summer meetings of the various societies shall not conflict with that of the Association. In order to bring about a change in this respect, the Association has voted to begin the meeting of 1896 on a Monday, continuing through the week with excursions on Saturday. It is believed that by this arrangement the affiliated societies will, as a rule, hold their meetings on the days following the Association week, or when that is not possible, on the days immediately preceding the Association week, so that the members of the various societies can take part in the corresponding sections of the Association. It is greatly to be hoped that the affiliated societies will preclude from their meetings such papers as will be appropriate and interesting in the sections of the Association. With some such plan as this, the affiliated societies would naturally strengthen the Association, whereas it is believed that some of them have had, heretofore, the opposite effect. At the Springfield meeting a special committee was appointed to consider this and other subjects pertaining to the welfare of

the Association, and there is little doubt, if these points are carefully considered, that some plan will result to save the great object of the Association from being jeopardized by the prevailing tendency of specialists to extreme subdivision in all departments of science.

I refer to the report of the General Secretary for the details of the Springfield meeting, and for my usual statement of the number of persons in attendance and the papers presented in the sections.

Of the 183 members elected since the Brooklyn and during the Springfield meeting, 4 have declined membership, 118 (including one associate who became a member), have perfected their membership, as have 5 who were elected at the Brooklyn meeting and 1 whose admission fee for that meeting was remitted by vote of Council; 36 members have paid their arrears and these have been restored to the roll; 2 more founders of the Association have been restored to the list of members and have been made honorary life members; 1 foreign honorary fellow has been elected, making 163 names added to the roll since the Brooklyn volume was published.

From the Brooklyn list 31 names (including 2 founders of the Association), have been transferred to the list of deceased members; 20 members and fellows have resigned, and 1 has been omitted for arrearages, making a deduction of 52 from the list.

Three members have become life members; 50 members have been transferred to the roll of fellows, and 1 fellow has been transferred to the list of honorary fellows.

The following is a comparative statement of the roll as printed in the Madison and Brooklyn volumes, and in the present volume:—

	Madison.	Brooklyn.	Springfield.
Living patrons,	2	2	2
Corresponding members,	2	2	1
Members,	1,138	1,042	1,115
Living honorary fellows,	1	1	3
Fellows,	796	755	772
	1,939	1,802	1,913
Honorary life members (founders) included in the above,		8	8

The distribution of publications since the last report is as follows:

Memoirs No. 1: sold 1 copy; presented 1 copy.

Proceedings: Vols. 1–42—delivered to members, 198; sold, 29; exchanges, 6; duplicate copies to members, 7; presented, 85; bought, 43 copies; received as donations, 19.

Vol. 43: delivered to members, 1277; sold, 27; exchanges, 246; duplicate copy to member, 1; presented, 6; bought, 2 copies; returned from members, 5; returned from exchanges, 2.

Subscriptions have been received for 4 copies of volume 44.

For several years past it has seemed to me desirable that the growing library of the Association should be placed where it would be of greater

benefit to science than it could be while stored in the office of the Association. It is therefore most satisfactory that the final arrangements were made at the Springfield meeting by which the library is to be transferred to the care of the University of Cincinnati under the following conditions:

"It is hereby agreed on the part of the officers of the American Association for the Advancement of Science and the Board of Directors of the University of Cincinnati to place the library of the Association in the charge of the University in accordance with the terms of the accompanying proposition:

(Signed)

EDWARD W. MORLEY,
President, American Association for the Advancement of Science.

F. W. PUTNAM,
Permanent Secretary, A. A. A. S.

C. G. COMEYNS,
Chairman Board of Directors of the University of Cincinnati.

JOSEPH F. WRIGHT,
Clerk, Board of Directors University of Cincinnati.

"The University shall bind itself:—

1. To provide proper accommodation for the library, good care of the same, and all reasonable facilities for direct consultation on the part of members of the Association and scientists in general.

2. To make provision for the consultation of books in the library by Fellows and Members of the Association (and by well-known scientists), residing at a distance, by the methods ordinarily adopted by the leading libraries of the country;

3. To bind suitably the annual additions;

4. To provide for the binding, within the space of five years, of the entire unbound portion of the library at the time of transference;

5. To maintain an insurance upon the library at a valuation to be fixed by mutual consent;

6. To maintain a complete card catalogue of the library;

7. To furnish to the Council of the Association a numbered manuscript catalogue of the library as at present constituted, after careful classification;

8. To furnish to the Council, annually, a similar catalogue of the additions of the year;

9. To place the executive management of the library under the direction of a competent librarian;

10. To place the library under the supervision of a standing committee of the Association (of five Fellows), resident in Ohio, Indiana, Kentucky or Tennessee;

11. To return to the officers of the American Association, upon one year's notice, at any time after 1905, the entire library as at present con-

stituted, and with all future additions, upon the refunding of the sum expended for binding."

"The Association binds itself:—

12. To deposit with the University the entire library, as at present constituted and all future additions, until the expiration of the contract through the fulfilment of the stipulations of the preceding paragraph."

"It is further understood:—

13. That all agreements respecting the library shall be signed by the President and Permanent Secretary of the Association, and by the Chairman and Clerk of the Board of Directors of the University of Cincinnati;

14. That in case of partial or total loss by fire, the insurance money received shall be paid over to the Treasurer of the Association after deducting a sum equivalent to that expended on the binding of the volumes destroyed;

15. That the Association commits itself to no expenditure in connection with the library other than that involved in the supplying of volumes of the Annual Proceedings to such scientific societies or periodicals as may wish to exchange publications with the Association and are approved by the Standing Committee on the Library."

F. W. PUTNAM,
Permanent Secretary.

January 1, 1896.

REPORT OF THE TREASURER.

IN compliance with article 15 of the Constitution, I have the honor to submit the following report showing receipts and disposition of funds of the Association for the fiscal year ending June 30, 1895.

The receipts which have come into the keeping of the Treasurer are of two kinds, namely: first funds on deposit in banks transferred by the Permanent Secretary to the Treasurer; and, second, accrued interest on those funds.

The funds received from the Permanent Secretary amount in the aggregate to $5,851.79. The amount received as interest on these funds up to June 30, 1895, is $80 33. The total amount of funds in the care of the Treasurer on the same date is $5,932.12.

With the exception of a balance of $36.20 on deposit in The Fifth Avenue Bank of New York, these funds are now deposited in savings banks which may be expected to pay not less than three and one-half per cent interest compounded semi-annually.

The details of the receipts and deposits are as follows:—

THE TREASURER IN ACCOUNT WITH
THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Dr.

August 21, 1894.	To funds on deposit with State Street Safe Deposit Company of Boston, Mass. . .	$5564 48
	To funds on deposit with Cambridge Savings Bank of Cambridge, Mass. . . .	287.31
June 22, 1895.	To interest on funds with State Street Safe Deposit Company of Boston for 1 year 3 months and 14 days at the rate of 1 per cent per annum	71.72
June 30, 1895.	To interest on funds in Cambridge, Mass., for 1 year at the rate of 3 and ½ per cent per annum compounded semi-annually	8.61
	Total	$5932.12

Cr.

July 1, 1895.	By cash on deposit with the Emigrant Industrial Savings Bank of New York, N. Y.	$2000.00
	By cash on deposit with the Institution for the Savings of Merchants' Clerks, of New York, N. Y.	2000.00
	By cash on deposit with the Metropolitan Savings Bank of New York, N. Y. .	1600.00
	By cash on deposit with the Cambridge, Savings Bank of Cambridge, Mass. .	295.92
	By cash on deposit with the Fifth Avenue Bank of New York, N. Y.	36.20
	Total	$5932.12

R. S. WOODWARD, *Treasurer.*

New York, June 30, 1895.

This report was duly audited by WILLIAM HARKNESS, appointed for the purpose by the Council, and his report, as auditor, was made to the Council on September 2, 1895, and placed on file.

F. W. PUTNAM, PERMANENT SECRETARY,

Dr. THE AMERICAN ASSOCIATION FOR

1894-95. *For the year ending*

To balance from last account		$1,275 00
Admission fees Brooklyn meeting	$810 00	
" " Madison and Rochester meetings	10 00	
" " Springfield meeting	55 00	
Associate members, Brooklyn "	183 00	
Fellowship fees	86 00	
Assessments Springfield meeting	264 00	
" Brooklyn "	1,959 00	
" Madison "	1,257 00	
" Rochester "	207 00	
" Washington "	42 00	
" Indianapolis "	15 00	
" Toronto "	6 00	
" Cleveland "	3 00	
		4,897 00
Publications sold and binding		245 96
Miscellaneous receipts		18 55
Life membership commutations		300 00
Due from research fund for grants paid* . . .		400 00
		$7,136 51

I have examined the above account and

CAMBRIDGE, AUGUST 21, 1895.

* Since received from the Treasurer.

IN ACCOUNT WITH

THE ADVANCEMENT OF SCIENCE. CR.

July 31, 1895. 1894–95.

By 2500 copies Proceedings Vol. 42; finishing the volume, paper, binding and wrapping:—		
J. Wilson & Son, printing and binding . . .	$542 59	
G. A. Aylward, printing	22 25	
Carter, Rice & Co., paper	93 75	
		$658.59
By 2500 copies Proceedings Vol. 43; in full for printing, binding, wrapping, extras of addresses, etc.:—		
J. Wilson & Son, printing and binding . . .	981 82	
J. Wilson & Son, extras of reports	4 50	
Amer. Publishing Co., wrappers for volume .	6 00	
G. A. Aylward, printing	882 02	
G. A. Aylward, extras of addresses and reports	101 96	
Carter, Rice & Co., paper	302 15	
Illustrations, drawing and engraving . . .	45 15	
		2,323 60
By expenses of Brooklyn meeting		271 82
Binding back volumes, etc.	17 25	
Back volumes bought	10 50	
		27 75
Printing notices, receipts, cards, etc.	51 00	
Engrossing and type-writing	29 90	
Stationery, etc.	14 29	
Travelling expenses of Assistant Secretary . .	1 20	
Press clippings	12 00	
Temporary office assistants	22 25	
		130 64
Subscription to Postal Guide	4 00	
Post office box	8 00	
Postage	243 52	
Telegrams	12 61	
Express	425 74	
		693 87
Office rent, one year		108 00
Salary of Janitor	100 00	
Salary of Assistant Secretary	720 00	
Salary of Permanent Secretary	1,250 00	
		2,070 00
Grant to Committee on Bibliography, Section G .	25 00	
Grant for Table Biolog. Lab., Cold Springs . .	100 00	
		125 00
Grant from Research Fund to Dr. F. Boas . . .	200 00	
Grant from Research Fund to Profs. Morley and Rogers	100 00	
Grant from Research Fund, Table Woods Holl Biol. Laboratory	100 00	
		400 00
Added to Research Fund, Life members commutation*		300 00
Balance to new account		27 24
		$7,136 51

certify that the same is correctly cast and properly vouched.

B. A. GOULD, *Auditor.*

* Since transferred to Treasurer.

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